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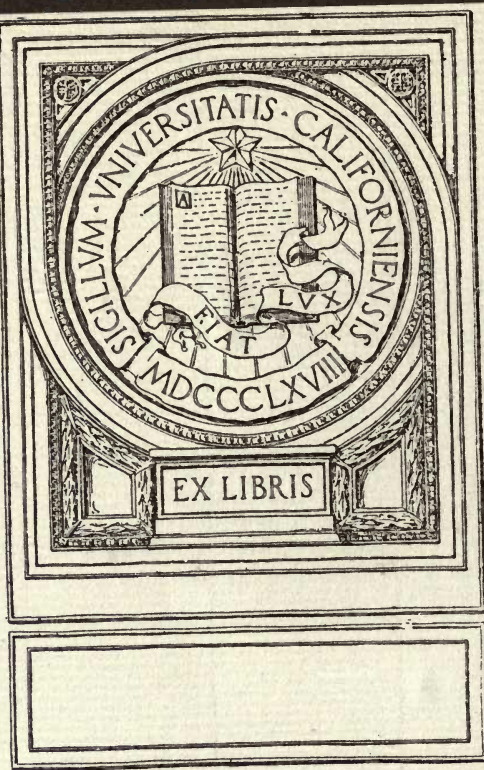
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UNIVERSITY OF

HISTORY

and

ENGINEERING REPORTS

on the

Columbia Southern Irrigation Project

Crook County, Oregon

Prepared for the Desert Land Board of Oregon

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TO WHOM
ADDRESS

EXECUTIVE OFFICE.

SALEM, OREGON, December 10, 1912.

Dear Sir: Referring to the Columbia Southern Carey Act Irrigation Project I wish to submit for your consideration five possible methods of completing the same.

- 1st, contract with A. D. Katz;
 - 2nd, contract with some other person or company;
 - 3rd, irrigation district;
 - 4th, U. S. Reclamation Service, either alone or through co-operation with the State of Oregon;
 - 5th, State reclamation.
-

1st. Mr. Katz at the present time has an option on the project which will expire on December 31, 1912. Nothing definite is now known regarding his plans. If he succeeds in financing the project, the terms of his contract with the State have already been agreed upon and there will be no occasion to present the matter to the legislature. If Mr. Katz fails, the completion of the project must be obtained through one of the remaining methods.

2nd. Should Mr. Katz fail, there is no likelihood that any other contractor will undertake the project. Private capital is at the present time very shy about investing in irrigation securities and especially Carey Act securities; and as the Columbia Southern project has so many complications and such a bad past record it would no doubt be useless to seek to interest any other person or company.

3rd. The completion of the project by the formation of an irrigation district has been suggested by resolutions adopted in September, 1912, by the Laidlaw Development League. This plan has many commendable features and deserves careful consideration.

The first question that will come up in connection with an irrigation district is the acreage to be included in the district.

At the present time 2,274.63 acres have been deeded, which contain about 1,800 irrigable acres. As this includes some of the best land in the project, and much of it is highly improved, it would afford the best of security for irrigation district bonds or assessments.

There are 3,406.36 acres of patented land which have not yet been deeded. The holders of some of this land could no doubt obtain deeds in the near future by completing payments and submitting final proof. The list of actual settlers prepared for Mr. Katz shows they hold about 2,800 irrigable acres, and that would probably represent the maximum irrigable acreage to which deeds can be obtained in the immediate future, or about 1,000 irrigable acres in addition to the present deeded irrigable land.

The Board of Control in adjudicating the water rights on Tumalo Creek determined that 3,057.75 irrigable acres had a vested water right. This would represent the maximum irrigated area up to the summer

of 1909. In addition the board awarded *inchoate* rights for 5,119.50 irrigable acres, provided they were irrigated by October 1, 1913. It is not likely that much of this area will obtain sufficient water to perfect the water right, and 5,000 irrigable acres will probably represent the maximum area which will obtain a good water right and a good land title. This would comprise about 2,800 acres of deeded Carey Act lands and about 2,200 acres of deeded private lands.

The irrigation district may be considered from two points of view; first, as a means of operating and maintaining the present system; and, second, as a means of completing the entire project.

The present Columbia Southern headgate and canal are in very poor condition, and if the system is to revert to the settlers they should have an organization ready to take over the project and raise sufficient funds to make extensive improvements. By properly fixing the main canal the losses from seepage can be materially reduced, and the water supply correspondingly increased. An irrigation district might provide a very good way to handle the project, as any assessments levied for maintenance, improvements or extensions would become a lien on the land and their collection could be enforced. The affairs of the district would be managed by officers elected every two years and the settlers would thus be in position to handle things to their own satisfaction. Should the owners of private lands not wish to be included in an irrigation district, the Carey Act settlers could form themselves into such a district and have ample area to enable them to operate the system to advantage.

But when the irrigation district is considered as a means of completing the entire system several difficulties are encountered. The holders of contracts with the old Columbia Southern Company for lands which have not been reclaimed could be included in the district, but the more lands the organizers attempt to include, the greater would be the difficulty of organization, and if some people are forced into an irrigation district against their will, it is bound to cause friction and litigation. But assuming that a district can be organized which includes the Carey Act and private deeded lands and also the unreclaimed Carey Act lands sold by the Columbia Southern Company, the next question is, how to finance the project?

It has been suggested that the State Land Board be authorized to purchase these irrigation district bonds. This, however, does not appear at all commendable. Assuming that the 5,000 irrigable acres mentioned above is all included in the district, said acreage would be the only land at the present time with any material value as security for a bond issue. It would not be worth more than an average of \$40.00 per acre, or a total of \$200,000 and could not be bonded for that much.

It is true that the irrigation district, after it is organized might obtain a contract with the Desert Land Board for the reclamation under the Carey Act, of the unsold land in the project, amounting to about 7,000 irrigable acres, and could offer Carey Act bonds for this land in addition to the district bonds for the other lands. But bonds based upon the unsold lands, and the unreclaimed, sold lands, would be poorly secured. Capital now thoroughly realizes that Carey Act liens offer very poor security, and it is almost impossible to sell Carey Act bonds covering a good, new project, let alone those covering a project with a history like the Columbia Southern.

In short, it would seem almost impossible for the officers of the irrigation district to succeed in financing the entire project. However, if Mr. Katz fails and no arrangements are made by the State, and the settlers wish to attempt to complete the project through an irrigation district, they should be given every encouragement and assistance possible.

4th. The next method to consider is the construction of the project by the United States Reclamation Service, either directly or through co-operation by the State.

It is believed that no effort has ever been made to induce the Reclamation Service to undertake the project. Oregon is entitled to the expenditure within the State of a large amount of the Reclamation Fund, and there is a bare possibility that the Reclamation Service, through Oregon's congressional delegation might be induced to undertake this project. But as there are opportunities in the State for the promotion of projects which are free from disagreeable complications, the Reclamation Service would be most certain to insist on taking up these new projects before considering the Columbia Southern project. And in attempting to get them interested in the project a long time would be wasted in fruitless negotiations.

The plan of co-operation between the State and the United States Reclamation Service for the development of the entire Deschutes Valley has been discussed to some extent. This plan, if it could be worked out would be a fine thing for the State. By taking the Deschutes Valley before it has been cut up into numerous independent holdings, and arranging for the development that would utilize to the best advantage all available water, would be a grand achievement. But this will require many years, and even if the legislature makes provisions for co-operation, it will be several years before any actual construction will be commenced, and it might not be possible to persuade the Reclamation Service that the Columbia Southern project should be taken up first.

And in this connection it should be borne in mind that the development of the Columbia Southern project by private capital, an irrigation district, or the State would not interfere with co-operative development, but would probably assist it. If it was found that the waters from Tumalo Creek could be used to more advantage lower down, and waters from the Deschutes applied on the Columbia Southern lands, such an arrangement could be made and the Tumalo reservoir still used.

5th. This brings us to a consideration of the completion of this project by direct action of the State, by which is meant the construction of a reclamation system with money appropriated by the legislature and expended under the direction of the Desert Land Board, or such other officer, board or department as the legislature may direct. It is believed that this is one of the most feasible and satisfactory methods of completing the project. While the State has incurred no legal liability on account of the failure of the project, there is no doubt that some moral responsibility rests with it to remedy conditions which, to a certain extent, are due to mistakes on the part of its officers.

The State Land Board no doubt felt that having relied upon its appointees to investigate this project, it should be held blameless, but the fact nevertheless remains that the project was not properly investigated, nor the contract properly drawn, and, as a result of these failures, the Company was permitted to make sales and collect money for much more land than there was water to irrigate. Inasmuch as many years have elapsed since the shortage of water was discovered, and the State has failed in its efforts to induce others to complete the project, it would seem if there is no other possible way of completing it, that the credit of the State could with propriety be loaned to aid in its completion.

The State does not guarantee Carey Act projects but purchasers invest in such lands very largely because they believe that the State will supervise the project in such manner as to protect their interests. The State failed to exercise proper supervision in this case, and it should there-

fore make a special effort to see that these purchasers, whose money was put into the project may eventually be protected, either by a return of the money through an opportunity to obtain desirable irrigated land at a fair price.

It is almost impossible, now, to sell Carey Act bonds because investors have learned by bitter experience that a Carey Act lien is very poor security. The result is that promoters are now attempting to finance projects on the funds of the prospective settler. This would be all right if he could be properly protected, but it is difficult to arrange for such protection. The settler must assume the risk, and when he finds that the State is not guaranteeing the completion of the project into which his money is to go, and that he will be without security he is very likely to decline to invest his money.

A proper and businesslike way of handling an irrigation project would be to have sufficient funds available to complete the construction work and have an adequate supply of water ready for immediate delivery to the land before it is placed on the market. The State could easily handle a project in this way.

To complete the Columbia Southern project so as to reclaim all the irrigable land in the original selection of 27,004.83 gross acres, would require, according to the State Engineer's estimate practically \$450,000, or an expenditure of \$225,000 a year for two years. If the State were to appropriate this amount, complete the project, and then place the lands on the market at an average price of say \$40.00 per acre, they could all be sold, and the money appropriated, together with interest, and a fair profit be turned back into the State Treasury.

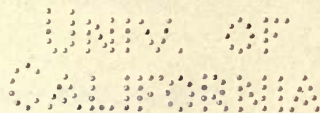
Your attention is particularly called to the Engineer's report on this project, a copy of which is attached.

Yours truly,

OSWALD WEST.



HISTORY



and

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Crook County, Oregon

Prepared for the Desert Land Board of Oregon



HISTORY OF THE COLUMBIA SOUTHERN PROJECT.

By H. C. Brodie, Assistant Secretary Desert Land Board.

SALEM, OREGON, November 20, 1912.

His Excellency, Oswald West, Governor of Oregon:

DEAR SIR: I submit herewith a brief statement, giving the past history of the Columbia Southern Project:

Although water filings were made and some construction done on this project prior to 1902, it was first called to the attention of the Board on February 7, 1902, at which time, upon the application of the Three Sisters Irrigation Company, a selecting agent and surveyor were appointed by the Board. On December 5, 1902, the State Land Board, acting on behalf of the State of Oregon, and the Three Sisters Irrigation Company, executed a contract for the reclamation of the lands in Carey Act Selection List No. 13. This contract fixed a lien of \$277,000.00, the lien to be afterward apportioned to the different tracts according to their value. One of the provisions in this contract was that after the execution of a contract between the United States and the State, any qualified person desiring to obtain any of these lands should sign an application in duplicate with the company, one copy of which should be filed with the Board and when such applicant had filed his release of lien with the Board, the State should issue deed without further payment.

No detailed plans and specifications were filed with the Board prior to the execution of this contract, although a brief statement as to water supply was submitted by Levi D. Weist, from which it was made to appear to the Board that an ample supply of water existed for the reclamation of all the lands in the project.

On January 12, 1904, the Secretary of the Interior executed a contract for the reclamation, under the Carey Act, of 27,004.83 acres. No office of the State Engineer existed at this time. The Board, on January 14, 1904, therefore, appointed A. E. Hammond to act as engineer, with the duty of supervising the reclamation of Carey Act lands. On April 1, 1904, the Three Sisters Irrigation Company submitted proof to the

Board that 12,259.49 acres had been reclaimed and asked the Board to so certify to the Interior Department, which was accordingly done by the Board, relying upon the report of their engineer and statement of the agent of the company. On April 7, 1904, the apportionment of lien made by Mr. Hammond was approved by the Board.

The Three Sisters Irrigation Company had done a great deal of work since the execution of their contract, and in September, 1904, Mr. Laidlaw, manager of the Company, reported to the Board that they had constructed 35 miles of main canal and 50 miles in laterals at a cost of approximately \$150,000, and that 1,000 acres of land had been watered during the 1904 season, and that they expected to irrigate 18,000 acres in 1905. Everything seemed to be going very nicely on the project.

The contract between the State and United States having been executed and lien apportioned, the company proceeded to accept applications and execute contracts for the sale of the lands. As the average price was only a trifle over \$10 per acre, the lands were sold very rapidly during the years 1904 and 1905, and the early part of 1906 contracts were executed for 17,929.1 acres, of which area, approximately 14,800 acres were irrigable land. In addition to this, the company executed contracts to sell water to 1360 acres of private land in the vicinity of the Carey Act land.

On January 19, 1905, the United States executed patent to the State for 11,695.48 acres, and on March 20, 1905, Mr. Laidlaw submitted a second list for patent, containing 6,293.72 acres.

Trouble began at the close of the 1905 irrigation season, when the Board received a letter from the Water Users' Association, advising that although only about 1,000 acres had been cultivated during that season, there had been some shortage of water and as a large area had been sold and would no doubt be settled in the near future, it was evident that the water supply would be much too small for the protection of purchasers.

On November 1, 1905, therefore, the clerk of the Board wrote the Commissioner of the General Land Office, requesting that action be suspended on the second list for patent, and the United States, therefore, returned this list to the State.

On November 8, 1905, the Three Sisters Irrigation Company conveyed its rights to the Columbia Southern Irrigation Company, which company, on November 10th, again conveyed the rights to the Columbia Southern Irrigating Company, which company continued to have charge of the project until placed in the hands of a receiver.

Early in 1906, the Board insisted that the company adopt rules for the distribution of water, which should be similar to those used on the Deschutes Irrigation & Power Company Project, and which would properly protect purchasers. This the company refused to do and no settlement having been reached after a number of meetings, the matters relative to this project were, on April 25, 1906, referred to the Attorney General. During the summer of 1906, it was made plainly apparent that although water rights had been sold to a large area, the water supply was sufficient for the irrigation of only from 2,000 to 3,000 acres. During that summer, about 60 settlers lived on the project and these settlers raised \$500 by subscription and had a survey made by the State Engineer which demonstrated the feasibility of completing the project by storage in the Wimer Flat Reservoir.

It was found impossible, however, for the Board and Columbia Southern Irrigating Company to agree as to any arrangement for completing the project, or to come to any satisfactory arrangement relative to rules for the distribution of water or forms of contract and release of lien to be used by the company, and on August 21, 1907, the Attorney General filed a suit in the Federal Court in the District of Oregon, asking for cancellation of the contract between the company and State on the grounds that the State had been induced to execute this contract through fraudulent representations by the representatives of the Three Sisters Irrigation Company, and that the company has failed and refused to complete its work and is now insolvent, and has wasted and misapplied a large portion of the money collected from settlers. This suit was finally determined in September, 1909, and was decided against the State, the court holding that there was apparently no fraud, but that a mutual mistake was made as to the feasibility of the project and that the contract could not be cancelled in a court of equity until an attempt had been made to affect cancellation in a manner provided by the State statute and that in any event, in any suit, all of the settlers must be made parties as their rights must be determined in the decree. The State decided not to appeal from this decision and since that time the history of the project is simply the history of the attempt to reorganize it and place it upon a satisfactory basis.

Almost immediately after the settlement of this suit, negotiations were begun for the complete investigation of the project and on December 30, 1909, a contract was executed between the Desert Land Board and the Oregon, Washington & Idaho Finance Company. This company agreed to make complete

engineering investigations and to execute a contract for the reclamation of the lands within eight months from that date. A number of extensions of time, however, were granted, as it was found impossible to interest finance and the last extension expired on March 1, 1912, at which time the engineering data collected, was turned over to the Desert Land Board.

This contract of December, 1909, had provided that the Oregon, Washington & Idaho Finance Company should obtain the title to the project from the Columbia Southern Irrigating Company, and if unable to go ahead with the project, should convey the title to the State. On February 1, 1911, a deed was executed by the Columbia Southern Irrigating Company conveying all of its property, water rights and interests of every kind in connection with the project, to the Oregon, Washington & Idaho Finance Company, and on December 15, 1911, the Oregon, Washington & Idaho Finance Company deeded to the State of Oregon all rights and interests of every kind in connection with this project. This deed was placed in escrow and was delivered to the Board in March, 1912, upon the failure of the company to finance the project by that time.

Although the Board, on March 1, 1912, held the title to the project, it was in no condition and had no funds to take actual charge of the project and as Mr. A. D. Katz, was willing to do so, the Board, on March 1, 1912, executed a contract with Mr. Katz, wherein he agreed to maintain the project during the year 1912, and to use his best efforts to finance the project, the Board agreeing that if he succeeded in financing the project to the satisfaction of the Board, on or before December 31, 1912, a contract would be executed with him for the reclamation of the lands, and a draft of this proposed final contract was prepared and attached as an exhibit, to the contract of March 1, 1912.

In October, 1909, the General Land Office called the State's attention to the fact that although patent had been issued for more than 11,000 acres, these lands had not been properly reclaimed and the United States therefore required the cancellation of this patent so far as it affected such unreclaimed lands, and therefore, on June 27, 1910, the State reconveyed the title to 6,014.49 acres, leaving a balance of land now patented to the State of 5,680.99 acres. Deeds have, from time to time been issued to settlers on this project and at the present date (November 20, 1912), the State has deeded 2,274.63 acres.

In 1909, proceedings were initiated before the Board of Control, as provided for in the Oregon Water Code, for the adjudication of the water rights on Tumalo Creek. This

adjudication was completed and on May 1, 1911, the Circuit Court for Crook County, issued a decree fixing the rights of all parties interested in the waters of Tumalo Creek. By this decree, vested rights were granted for the irrigation of 3,057.75 acres. About 700 acres of this is for private lands and the balance for lands in the segregation. Inchoate rights were allowed for 5,119.5 acres, of which approximately 2200 acres are private lands and the balance Carey Act lands. The holders of inchoate rights are allowed until October 1, 1913, in which to complete the reclamation of their lands in order to perfect their water rights. The decree fixes the priority for the private lands watered from private ditches, as earlier than that for the lands watered through the Columbia Southern ditch, all lands watered through the Columbia Southern ditch having a priority date of September, 1900. In addition to these vested and inchoate rights, the court gives a right to the Columbia Southern Irrigating Company with a priority date of June 1, 1907, for the reclamation of the balance of the lands in the segregation, provided such lands are reclaimed on or before October 1, 1917. As the water rights of the Columbia Southern Irrigating Company are owned by the State, and as all rights on the stream have been accurately determined, this feature of the project is apparently in such condition that no litigation relative to water rights should arise in case satisfactory arrangements are made for continuing the development of the project.

The Columbia Southern Irrigating Company, at the time the project was placed in the hands of a receiver, held settlers' notes for deferred payments under their contracts. Practically all of these settlers ceased making payments when the trouble between the Board and company began and these notes were deposited with the Oregon Trust and Savings Bank, as trustee. They later came into the possession of Mr. A. E. Clark, who held them to protect his attorneys lien for services rendered the Columbia Southern Irrigating Company. On June 26, 1912, however, Mr. Clark transmitted all of these notes to the Governor, advising him that while he felt his lien should be protected as against the Columbia Southern Irrigating Company, the Oregon, Washington & Idaho Finance Company, or their successors in interest, he would waive any claim as against the State and authorized the Governor to make such use of these notes, either by cancellation or otherwise, as in his judgment will advance the welfare of the irrigation project.

At the present time, therefore, all the water right complications have been terminated, the title to the project is held by

the State, and everything would appear to be favorable for a reorganization of the project by Mr. Katz, or, if he is unable to do so, by the State.

Respectfully submitted,

H. C. BRODIE,

Asst. Secretary Desert Land Board.

SALEM, OREGON, November 7, 1912.

His Excellency, Oswald West, Governor of Oregon:

DEAR SIR: In compliance with your recent request I transmit herewith a report on the Columbia Southern Project, prepared by Mr. O. Laurgaard, chief engineer in charge of this project for the past two years for the Oregon, Washington & Idaho Finance Company and for Mr. Alma D. Katz. This report presents the latest and most complete data available relative to this project, and is based not only on Mr. Laurgaard's personal investigation, but also on the various engineering reports which have been prepared on this project at various times by Mr. Chas. L. Swain, Mr. Frank C. Kelsey, Mr. H. W. King and Mr. D. C. Henny. Mr. Laurgaard's report made, as it was, by a reputable engineer, after a careful and long continued investigation is more reliable and covers the project more in detail than any report that could be made at this time by this office, without a complete and comprehensive survey and engineering investigation of the project.

If the construction of a 35,000 acre project is contemplated, I would not deem it necessary to submit anything further than Mr. Laurgaard's report. It is my understanding, however, that information relative to the project is desired by you, with a view of making recommendations to the legislature relative to the completion of the project by State Reclamation. I have, therefore, supplemented Mr. Laurgaard's report with some estimates as to cost, in case the State should wish to reclaim only those lands included in the original Columbia Southern Carey Act Segregation. My estimates are based upon Mr. Laurgaard's, simply making the necessary reductions on account of the decrease in size of some of the structures.

The attached report by Mr. O. Laurgaard is based on the cost of reclaiming 35,000 acres of irrigable land and while the acre cost of this project will probably be less than the acre cost of reclaiming the smaller area, yet the total cost of reclaiming only those lands included in the original segregation list No. 13 will be much less than the total cost of reclaiming

the 35,000 acre project. Oregon Desert Land Segregation List No. 13 covered 27,004 acres of which it is estimated that 21,300 acres are irrigable.

At the request of the Oregon, Washington and Idaho Finance Company, a temporary withdrawal was secured covering approximately 5,000 acres of land adjoining the Columbia Southern segregation, of which between three and four thousand acres are irrigable. However, none of this temporary segregation has been sold to prospective settlers nor does any of the present constructed irrigation system cover any part of this temporary withdrawal and for these reasons, it would seem that these lands could be readily eliminated from further consideration without injustice to anyone, and their elimination would considerably reduce the appropriation required to construct the project. Hence, in this report, only those lands included in the original segregation list, together with such other lands which may have prior vested water rights will be considered in this report.

All rights to the use of water on Tumalo Creek have been determined and placed on record by the Board of Control and in this determination, certain vested and inchoate rights were granted to private lands. These lands aggregate about 3,200 acres, 1,000 of which will be covered by the reservoir, leaving 2,300 for which water must be supplied. This report will, therefore, take into account the following acreage:

Irrigable acres of segregated land.....	21,300
Irrigable acres of private land	2,200
Total.....	23,500

WATER SUPPLY.

For the amount of water available at the proposed new diversion from Tumalo Creek, Mr. Laurgaard's figures have been accepted and the years 1910 and 1911 taken as a safe period upon which to base an estimate of the water supply. The irrigation season, as fixed in the attached report, seems to be somewhat long in view of the fact that only 1.8 acre feet is to be delivered on the land during this period. This is the same quantity of water that is required to be delivered on the Central Oregon Irrigation Project in 90 days. However, the soil in the Columbia Southern segregation is considerably better, there being less waste land. This amount may therefore be sufficient for the irrigation of these lands and has not been changed. A loss of 30% between the headgate and the land has been assumed.

The following table gives the amount of water available and the amount required for the irrigation of 23,500 acres of irrigable land.

Year 1910-1911	Recorded flow of Tumalo Creek	Estimate of increase at intake new feed canal	Total available at head-gate	Depth on land in feet	Amount required on 23,500 acres	Amount required at head-gate for 23,500 acres	Amount required for storage	Amount available for storage
October 16-31	2,560	-----	2,560	-----	-----	-----	-----	2,560
November	4,110	-----	4,110	-----	-----	-----	-----	4,110
December	6,820	-----	6,820	-----	-----	-----	-----	6,820
January	5,060	-----	5,060	-----	-----	-----	-----	5,060
February	5,040	-----	5,040	-----	-----	-----	-----	5,040
March	5,530	-----	5,530	-----	-----	-----	-----	5,530
April	5,670	2,155	7,825	.12	2,820	4,029	-----	3,796
May	8,240	783	9,023	.25	5,875	8,393	-----	630
June	15,900	-----	15,900	.33	7,755	11,079	-----	4,821
July	8,610	-----	8,610	.41	9,635	13,764	5,154	-----
August	4,430	-----	4,430	.41	9,635	13,764	9,334	-----
September	4,040	-----	4,040	.20	4,700	6,714	2,674	-----
October 1-15	1,990	-----	1,990	.08	1,880	2,686	696	-----
Totals	78,000	2,938	80,938	1.80	42,300	60,429	17,858	38,367

From Mr. Laurgaard's capacity curve it appears that a 59-foot dam will store 18,000 acre-feet.

It will be observed that storage to the amount of 17,858 acre feet will be required to supplement the regular flow of the stream. This will be stored in Tumalo reservoir.

It may be well to note here that the Board of Control, in its determination of the water rights of Tumalo Creek, granted certain vested and inchoate rights to settlers on the segregation and to the company, in trust for other settlers, independent of the general inchoate right of the company for the balance of the segregation. In round numbers, the lands having a prior water right to the land of the segregation, are as follows:

Carey Act lands in the segregation	5,000 acres.
Private lands covered by same distribution system.....	1,000 acres.
Private lands covered by reservoir	1,000 acres.
Private lands lying above diversion canal	1,000 acres.
Total	8,000 acres.

Eliminating from consideration the 1,000 acres in the reservoir site, which would be flooded, leaves a balance of 7,000 irrigable acres which has a water right prior in time to the balance of the sepreparated lands.

To supply this land according to the schedule upon which the attached report is based would require during April 840 acre feet, during May, 1,750 acre feet, June 2,310 acre feet, July 2, 870 acre feet, August 2,870 acre feet, September 1,400 acre feet, October 560 acre feet. Referring to the table pre-

ceding, it will be noted that sufficient water is available to supply these lands from the direct flow of Tumalo Creek, without storage. However, should this amount of land be placed under cultivation, with no change in the present constructed works, there would be a shortage of water on account of the extremely heavy losses in the present diversion canal.

RESERVOIR.

The 18,000 acre feet of storage required will be stored in the Tumalo Reservoir and no excess capacity will be necessary as losses by seepage and evaporation will be compensated for by precipitation and surface water from the reservoir drainage area. For the storage of 18,000 acre feet it will require a depth of water at the dam of 59 feet and a dam 64 feet in height. Such a reservoir will approximately cover 1,000 acres of land, all of which is held in private ownership. In estimating the quantities in the dam, they have been taken as 62 per cent of the quantities in the dam designed by Mr. Laurgaard.

In order that the construction of the dam may not prevent the maximum development at some future time, by increasing the height of the dam, the outlet conduits have not been changed from the design given in the report of Mr. Laurgaard. The dam can then be raised to its maximum height at any time without interfering with the dam as constructed.

Only a small reduction can be made in the cost of constructing the auxiliary dam as this includes the waste way for the reservoir, which will have to be as large for the smaller reservoir as for the larger. It will be necessary to purchase 1,000 acres of private land to be covered by the reservoir and this has been estimated at \$50.00 per acre. Mr. Lauregaard, in his report, has fixed the value of these lands at \$66.00 per acre. It is believed that this figure determined upon on account of \$66.00 per acre being the maximum lien allowed by the Board in the preliminary contract with Mr. Alma D. Katz for irrigated lands in the segregation.

Should the State construct these works, the actual selling price of the lands will be less than \$40.00 per acre, and certainly \$50.00 per acre would be a fair price for these lands. This would place the cost of the lands in the reservoir at \$50,000. On the foregoing basis, the estimate for the construction of the reservoir has been revised, as follows:

TUMALO DAM.

87,000 cu. yds. earth excavation and fill at 60 cents.....	\$ 34,200 00
4,335 cu. yds. concrete core at \$11.00	47,685 00
2,295 cu. yds. excavation cut-off trench at \$1.25	2,868 75
1,980 cu. yds. excavation drain trench at \$1.00	1,980 00
2 acres stripping at \$300.00	600 00
8,470 cu. yds. riprap at \$1.75	14,822 50
1,500 cu. yds. excavation for tunnel, open cut at \$1.50	2,250 00
400 ft. excavation tunnel 8'x8' at \$20.00	8,000 00
200 ft. concrete lining, 300 cu. yds. at \$18.00.....	5,400 00
70 ft. shaft excavation 6'x8' at \$40.00	2,800 00
75 ft. concrete lining, 100 cu. yds at \$18.00	1,800 00
2 gates, rods, stands, grillings, etc., in place	5,000 00
1 gate house	1,000 00
Total	\$128,406 25

AUXILIARY DAM.

Dam and outlet conduits	\$ 10,000 00
Spillway	5,500 00
Total	\$ 15,500 00

TOTAL COST OF CONSTRUCTION OF RESERVOIR.

Tumalo Dam	\$128,406 25
Auxiliary Dam	15,500 00
Lands	50,000 00
Roads, etc.	1,700 00
Total	\$195,606 25

FEED CANAL.

The feed canal must be designed to carry sufficient water not only for the 21,300 acres of segregated lands but also for the one thousand acres of private land, securing water from the same distribution system. On the basis of one second foot for eighty acres, the maximum rate granted in permits from the State Engineer's office, the canal would be required to carry 279 second feet. The canal has, however, been designed with a capacity of 300 second feet and this would without doubt be ample capacity to fill the reservoir.

The quantities of excavation and lumber for flumes have been estimated at 6-7 of Mr. Laurgaard's estimates. No reduction has been made in the estimated cost of the diversion dam.

COST OF FEED CANAL.

Diversion Weir	\$ 5,000
Flumes, 6,000 ft. at \$4.50	27,000
Trestles, 1,000 ft. at \$2.00	2,000
Excavation for flumes, 5,000 lin. ft., 6,430 cu. yds. at 40 cts.	2,570
Canal excavation, 8,100 lin. ft.—	
15,770 cu. yds. at \$1.25	19,700
11,570 cu. yds. at 50 cts.	5,780
23,500 lin. ft. 60,690 cu. yds. at 30 cts.	18,200
Right of Way, cost of land, about 80 acres	1,600
Clearing right of way	3,200
By-pass and drop into reservoir	3,000
Total	\$ 88,050

DISTRIBUTION SYSTEM.

In estimating the cost of the distribution system, the private lands to be watered from the same system must be considered, for the distribution system already constructed, and for which an allowance of \$45,000 is made, covers these private lands.

At \$6.50 per acre, the distribution system for 22,300 acres would cost in round numbers, \$145,000. Deducting \$45,000, the estimated value of the present works, it would leave \$100,000 to be expended on the distribution system.

RECAPITULATION OF COST.

Tumalo Dam	\$128,406 25
Auxiliary Dam	15,500 00
Feed Canal	88,050 00
Reservoir roads and excavation of cut	1,700 00
Engineering, contingencies, incidentals, administration, 15%	50,048 44
Land purchases necessary for reservoir, 1,000 acres at \$50.00	50,000 00
Preliminary investigations	10,000 00
Total cost	\$443,704 69

For the construction of the remainder of the irrigation works necessary for the complete reclamation of the lands in Oregon Desert Land Segregation List No. 13, it will require, therefore, \$443,704.69, and if the State is to undertake the reclamation of these lands, this amount should be appropriated and made available for expenditure within the ensuing two years.

REORGANIZATION OF THE PROJECT.

In considering the reorganization of this project, we have four classes of land with which to deal. First, private lands in the project to which the Columbia Southern Co. contracted to deliver water and the Board of Control decreed water rights; second, segregated land in the project to which the Board of Control decreed a water right, prior in time to the general inchoate right for the remainder of the segregation; third, segregated land contracted for sale by the Columbia Southern Company, to which the Board of Control decreed no water rights, other than a general inchoate right for the project; fourth, unsold segregated land.

Omitting the first class, which contains about 1,000 acres of irrigable land, we have,

	Irrigable	Gross
Second class, segregated lands with prior water rights	5,000	6,100
Third class, other segregated lands under contract	9,800	11,900
Fourth class, unsold segregated lands	6,500	9,000
Totals	21,300	27,000

The Columbia Southern Irrigation Company contracted to deliver water to the 1,000 acres of irrigable lands in the first class and a large part of the agreed price of the water rights for these lands is yet unpaid. However, owing to the fact that the lands at the present time have a reasonably good water right, it may be impossible to collect the outstanding balance, and even if it should be collected, it might be claimed by the original contractors as the reclamation system for these lands is practically complete. For the same reason, it is doubtful whether these lands would contribute in any way to the reconstruction of the project.

Lands of the second class are in practically the same condition as those of the first class, and it is doubtful whether the unpaid balance could be considered as an asset of the project. It is also extremely doubtful whether these lands would contribute to the reconstruction.

It is estimated that about \$95,000 has been paid under contracts for lands in the third class, and as this amount was paid in good faith, the purchasers should be entitled to an allowance of the amount paid. \$95,000 must therefore be added to the cost of construction of the project to arrive at the minimum price at which the lands could be sold.

The lands of the fourth class could be sold at any price at which they would find a ready sale, and it may be advisable to fix a higher price on the irrigable land in this class than on the irrigable land in the third class in order to encourage the present contract holders to retain their contracts and thus avoid the necessity of reselling the land.

The estimated cost of the construction of the project is \$443,704.69, to which must be added \$95,000, making \$538,704.69 as the minimum cost at which the land can be sold. As stated above, it is probable that classes Number One and Number Two would bear no part of this cost. This would leave 18,000 acres, of which 16,300 are irrigable, to bear this cost, or \$33.05 per irrigable acre. This land would easily stand this cost, and in order to guard against unforeseen contingencies and insure the return of the original appropriations to the State, an additional charge of five dollars should be made against each irrigable acre, making the average selling price \$38.05.

Should the project be constructed at the cost herein estimated and the land sold at an average price of \$38.05 per irrigable acre, an excess of \$81,500 would be returned to the State, over and above the original appropriation.

SUMMARY OF IMPORTANT FEATURES OF THE PROJECT.

Total irrigable acreage to be reclaimed from Tumalo Creek	\$ 23,500 00
Lands below proposed diversion canal	22,300 00
Irrigable acreage upon which cost must be assessed.....	16,300 00
Reservoir: Height of dam,..... 64 feet	
Area 1,000 acres	
Capacity 18,000 acre feet	
Auxiliary Dam: Height 20 feet	
Total cost of Reservoir, including lands, roads, etc.....	\$195,606 25
Feed Canal: Capacity, 300 second feet.	
Cost of Feed Canal	88,050 00
Distribution System: Cost	\$145,000
Allowance for present system	45,000
Net cost of distribution system	100,000 00
Total cost, which is appropriation required	443,704 69
Credit to be allowed for payments on contracts.....	95,000 00
Cost per acre for 16,300 acres	33 05
Selling cost per acre, for 16,300 acres	38 05

Should the State undertake the reclamation of this project, and the necessary appropriation made for this purpose, it will be necessary to make surveys to check these estimates for the reduced area. Other factors may enter into the construction of the project, after the reduction of the area, which do not appear in Mr. Laurgaard's report, but it is believed that the foregoing revised estimates are safe and conservative.

Respectfully submitted,

JOHN H. LEWIS,
State Engineer.

PORTLAND, OREGON, March 12, 1912.

Mr. A. D. Katz, Portland, Oregon.

DEAR SIR: In accordance with your request I herewith respectfully submit a complete report on the Columbia Southern Irrigation Project which is a summary of all my previous reports to the Oregon, Washington & Idaho Finance Co., with some additions and modifications. The work of surveying, locating, platting and mapping necessary for this report was completed under my direct supervision, and the maps, plans, specifications, and exhibits hereto attached have been carefully prepared after long and continued investigation on the ground and over the project.

GENERAL DESCRIPTION.

The project is situated in Crook County, Central Oregon, on the west side of the Deschutes river about 140 miles south of the Columbia River, extending from about two miles south of Laidlaw to two miles north of Cline Falls, and embracing an

area about fifteen miles long and from six to eight miles wide. The lands lie in townships 15, 16 and 17 south, ranges 11 and 12 east in The Dalles land district.

The Oregon Trunk and Deschutes Railroads on the east side of the river both parallel the project with the towns of Deschutes, Redmond and Bend, each three, four and five miles distant respectively from the project, thus insuring the very best transportation facilities. Laidlaw is three miles west of Deschutes and seven miles north of Bend, while Cline Falls is four miles west of Redmond.

BRIEF HISTORY OF PROJECT.

The project was originally taken up by the Three Sisters Irrigation Company, their water appropriation filings on the Tumalo Creek dating back as far as 1893. They commenced construction of their canals in 1900. In December, 1902, the Three Sisters Irrigation Company entered into a contract with the Desert Land Board of the State of Oregon, to reclaim 27,000 acres of desert land under the terms of the Carey Act. The company submitted to the State, a statement of the amount of water available in Tumalo Creek, plans for an irrigation system and an estimate for the cost. The cost of reclaiming the lands was fixed at an average price of \$10.00 per acre, and \$1.00 per acre annual maintenance fee.

The company constructed the main canal and main laterals, and sold considerable lands and water rights. The Columbia Southern Irrigation Company, who were the successors to the Three Sisters Irrigation Company, soon found that the flow of Tumalo Creek as estimated was far in excess of the actual minimum flow, and trouble arose as more land had been sold than could be actually irrigated by the normal flow of the creek. The State notified the company that storage reservoirs should be provided before the State would apply for further patents to the land from the Government. The State also cautioned the purchasers of patented land not to make any more payments as it would be doubtful if they would secure the lands or water rights, unless storage reservoirs were built.

Much dissatisfaction resulted among the settlers on account of the inadequacy of the whole system and the shortage of the water. The result was that a report on the project was prepared by the State Engineer, to determine the value of the project as built by the company, and determine its efficiency; but nothing definite was accomplished in the way of a reorganization until the Oregon, Washington & Idaho Finance Company took an option on the holdings of the Columbia Southern

Irrigating Company and obtained a preliminary contract with the State Desert Land Board for the complete investigation of the project.

The Oregon, Washington & Idaho Finance Co., made surveys and complete investigations of the whole project including the water supply, which established conclusively the feasibility of the project. They also had the water-rights under Tumalo Creek adjudicated, and completed all other necessary arrangements for a reorganization. Under date of February 1, 1911, a deed was given to the Oregon, Washington & Idaho Finance Company, by the Columbia Southern Irrigating Company, which conveyed all their holdings, water-rights, franchises, etc. Under date of December 15, 1911, the Oregon, Washington & Idaho Finance Company, gave a deed to the State of Oregon for all its rights, franchises, water-rights, etc., so that at the present time the State owns the project.

On March 1, 1912, the State cancelled the original Three Sisters contract and executed a preliminary contract with Mr. Alma D. Katz, whereby he was given charge of the project and authorized to proceed with the organization of a company for the reconstruction of same. In this contract the State agrees to execute a permanent contract with Mr. Katz, or his assigns, establishing a lien on the lands under the Carey Act on or before December 31, 1912, provided he has completed the organization of a company that is prepared to construct the project. A copy of the contract between Mr. A. D. Katz and the State of Oregon, together with the permanent contract which has been agreed upon, is attached to this report marked "Exhibit Number 1."

LANDS.

The irrigable lands are situated at an elevation from 100 to 400 feet above the Deschutes River, lying for the most part on an east and north slope. The topography of the country is smoothly rolling, with just enough slope to facilitate irrigation. The elevation above sea level varies from 2900 to 3500 feet.

The lands for which water rights will be sold are divided into two classes; those segregated by the State under the Carey Act, and those held under private ownership. The Carey Act withdrawals are held under two lists, the original segregation list number 13 of 27,000 acres, and temporary withdrawal list number 34 of 4700 acres. Of this total number of 31,700 acres withdrawn, about 24,000 acres are estimated as irrigable land, the balance being classed as non-

irrigable either on account of lying too high to be susceptible of irrigation or on account of being rocky or waste land. Water rights for the balance of 11,000 acres of irrigable land will be sold to owners of private land. The total number of acres of irrigable land available under the project is between 40,000 and 45,000, with a gross area of about 60,000 acres so that there is a great deal more land available than water to supply same.

Nearly all the lands are covered with sage brush and bunch grass, with large portions covered with juniper trees. The junipers are of large growth, can be very easily uprooted and are of some value as fence posts and wood.

The soil is composed of disintegrated lava and is commonly called volcanic ash and pumice dust. Much of the lava is soft and porous instead of being hard and brittle, and the disintegrated rock becomes a soil capable of retaining a large amount of water. The soil although fertile in most cases, is not uniformly deep, varying according to the proximity to rock ridges. Lands under the Columbia Southern project are deeper than those across the Deschutes River under Central Oregon Irrigation Company's segregation, and it is conceded by the local people that the lands are much better. In places clay and gravel are found, and there are a few localities in which there is gravely loam. The surface soil is in general about five feet deep, although it varies from 2 to 8 feet before it strikes the gravely subsoil. The land has an even drainage and there is no possibility of any portion of it becoming wet and swampy. At the present time there are no indications whatever of existing alkali. In general the lands are good and with water they raise good crops. Some of the best lands were taken up before the segregation was made by the State, and upon inquiry I find that nearly all the lands in private ownership are anxious to buy water as they cannot depend on a crop without it.

An analysis of the soil under the project has been made and is attached hereto, marked "Exhibit Number 5."

CLIMATE.

The nearest station where records have been kept by the United States Weather Bureau is at Bend, six miles from Laidlaw. The elevation at Bend is 3,630. The contents of this paragraph are obtained principally from the climatological service of the Weather Bureau. In general the climate is dry and subject to great extremes of temperature; there is an abundance of sunshine and for that reason, as well as the

dryness of the air, the extremes of temperature are not so noticeable as they otherwise would be. In the vicinity of the project the temperature sometimes goes below the freezing point in mid-summer, but does not remain below this mark long enough to injure hardy vegetation. Sometimes the temperature raises above 100 degrees, but such great heat is rare and does not last long. There are, usually, short spells every winter with zero temperatures and weather of this character may occur in December, January, or February, but seldom is so low a mark reached in November or March, although in these months it has been that cold on a few occasions.

The precipitation in the bottom of the Deschutes Valley averages about 12 inches, and increases rapidly with the elevation, being about 86 inches at the summit of the Cascade Mountains. At Bend the average precipitation is about 16 inches. The precipitation is heaviest in the winter months and lightest in July and August. There is a secondary maximum in May and June, which is welcome as it comes at the season of the year when the crops need the most moisture; this secondary maximum is very pronounced at Bend. About 23% of the precipitation occurs in the form of snow which may fall in small quantities as early as November, but is heaviest in January. The snow cover generally disappears sometime in March, although a light snow fall has sometimes occurred in April.

The following statistics were obtained from the weather bureau and represent an average covering a period of eight years:

STATION, BEND, OREGON.

	Precipitation	Mean temperature	Highest temperature	Lowest temperature	Average depth of snowfall
Annual.....	16.08	44.8	102	-19	45.9
January.....	2.48	30.9	59	-19	13.5
February.....	1.97	34	66	-19	9
March.....	2.27	36.8	72	-13	6
April.....	.83	43.4	84	8	1.2
May.....	.95	49	93	11	.3
June.....	1.15	52.2	93	22	-----
July.....	.56	62.7	102	23	-----
August.....	.35	62.1	98	26	-----
September.....	.51	53.7	92	12	-----
October.....	.40	49.3	86	14	-----
November.....	2.46	29.2	69	-4	3.1
December.....	2.10	31.9	61	-11	10.8

The prevailing direction of the wind is southwest. Strong winds are not as a rule frequent in the vicinity of the project, but when they do occur it is usually in the spring of the year and last for about two or three days. On account of cool

nights, uncertain winds, and by comparison with similar regions, I have estimated the evaporation in the vicinity of the project about 48 inches per annum.

Sand storms, which often occur on arid lands in the west, are unknown in the vicinity of the Columbia Southern Project, on account of the lands being covered with sage brush and juniper trees, scarcity of wind storms, and the volcanic origin of the soil.

Although a slight frost may occur at night in almost every month of the year, crop failures from this source are practically unknown where access is had to water for irrigation. Several instances have come to the writer's notice under the Columbia Southern Project when slight frosts occurring in May, might injure quite materially a crop raised by dry farming methods, but in an adjacent field where irrigation was used no bad effects could be noticed. When no irrigation is resorted to the climatological service of the Weather Bureau has found for the Deschutes Valley that when a temperature of 26 degrees is reached damage usually ensues, and the interval between the last temperature of 26 degrees in the spring and the first in the fall constitute the growing season for the staple crops raised in the valley. This season usually begins the middle of May and lasts until the middle of September.

CROPS.

Under the project at the present time there are about 4,000 acres irrigated from Tumalo Creek, which is the chief source of the water supply for the project. There are no crop failures where irrigation is practiced, and where water is available for use when needed. The farmers under the project have raised crops now for over seven years so the crops are no longer an experiment but they have demonstrated what can be done. Grasses of all kinds thrive; alfalfa, clover and timothy do very well. Two and three crops are cut; where but two are cut the field is usually used for pasture for the balance of the season. From three to six tons of alfalfa and clover are raised per season to the acre, while individual farmers sometimes cut as high as three tons at one cutting. Undoubtedly when the whole project is put under irrigation three good crops of alfalfa or clover should be the rule. Vegetables of all kinds, potatoes, turnips, beets, onions, etc., are staple crops for the project. Last season some farmers on small tracts raised over 500 bushels of potatoes to the acre. Grains of various kinds are raised quite successfully, but up to the present time on account of the high prevalent prices for

hay, most of the grains have been cut for that use. Individual farmers, however, have threshed from 25 to 40 bushels of wheat per acre. Fruit and berries are successfully raised on the project by individual farmers in isolated districts, but on account of the altitude and frost conditions these crops can not be considered as staple, nor could they be raised commercially with success.

Hog raising and dairying is especially adapted to the project. These industries have already commenced and as to the ultimate success of them there can be no doubt, as the conditions are especially favorable for production, while good transportation facilities are already at hand to convey the products to a ready market at Portland.

WATER SUPPLY AND HYDROGRAPHIC DATA.

The chief source of water supply for the project is Tumalo Creek, which is one of the tributaries of the Deschutes River, which has its source among the snow covered peaks of the Cascade Mountains. The drainage area of the creek has been estimated by the U. S. Geological Survey as 45 square miles, at the gaging station established above the intake of the old Columbia Southern canal. The flow of Tumalo Creek will be supplemented by, 1st, the increased drainage area of Tumalo Creek of about 10 square miles, caused by the new location of the proposed feed canal about eight miles down the stream from the old headgate; 2nd, the flow of Crater Creek, Little Crater Creek and various springs which have their source from glaciers on the top of Broken Top Mountain; 3rd, by the run off from the Tumalo Reservoir drainage area, which covers approximately 25 square miles and includes the Bull Creek Spring which flows continuously.

I. TUMALO CREEK.

The flow of Tumalo Creek is quite uniform in comparison with most mountainous streams in the west. The minimum flow recorded is about 60 c. f. s., while the usual maximum is about 450 c. f. s. The maximum recorded flow up to the present time is 820 c. f. s. The uniform flow is due to the supply of the creek from springs, glaciers and the even melting of the snow in the mountains, aided no doubt by the fact that a great portion of the drainage area is heavily timbered, most of which is withdrawn as a forest reserve.

The gaging station on Tumalo Creek was established by the Government on May 15, 1906. Six measurements of the flow were made in 1905, however, which have been used, and

are of benefit only inasmuch as they show that it was not a season of minimum flow. The first station established was located about one-half mile above the headgate of the Columbia Southern canal and below the headgate of the Wimer Ditch. The gage heights at this station, called the Laidlaw Station, were read only during the irrigation season from April to October, and the discharge obtained by adding the flow of the creek and the Wimer canal. On April 1, 1908, the gaging station was moved to a point about one and one-half miles above the intake of the Columbia Southern, and about 300 feet above the Wimer canal. This station is called the New Laidlaw Station. During the winter months, however, no records have been kept at the Laidlaw or New Laidlaw Stations, except the season October, 1908 to April, 1909, but another station was used at the Bend-Sisters bridge which is located about 8 miles down the stream from the New Laidlaw Station. This station at the bridge is called the Bend Station. The intake of the new feed canal is located about one mile down the creek from the Bend Station and about two miles above the mouth of the creek.

The records of the flow of Tumalo Creek for each irrigation year from May, 1906, by months, is as follows:

Month	1905-6		1906-7		1907-8		1908-9		1909-10		1910-11	
	A. F.	Sta.	A. F.	Sta.	A. F.	Sta.	A. F.	Sta.	A. F.	Sta.	A. F.	Sta.
Oct.-----	Estimat- ed at low- est previ- ous record	-----	7,860	L & W	6,390	L & W	5,820	N L	4,890	N L	4,920	N L
Nov.-----		-----	14,400	B	4,430	B	*5,500	B	*14,400	-----	4,110	B
Dec.-----		-----	8,920	B	5,290	B	*5,360	B	*8,920	-----	6,820	B
Jan.-----		-----	14,400	B	5,540	B	4,840	N L	*5,000	-----	5,060	B
Feb.-----		-----	11,400	B	5,630	B	4,290	N L	*5,000	-----	5,040	B
March-----		-----	9,280	B	5,440	B	4,670	N L	*5,000	-----	*5,590	-----
April-----		-----	7,910	L & W	7,560	N L	*7,220	-----	8,070	N L	5,670	N L
May-----		L & W	17,200	L & W	9,590	N L	10,400	N L	12,100	N L	8,240	N L
June-----		L & W	19,200	L & W	17,000	N L	15,800	N L	9,580	N L	15,900	N L
July-----	13,430	L & W	16,700	L & W	16,200	N L	9,350	N L	6,330	N L	8,610	N L
August-----	6,190	L & W	7,670	L & W	5,540	N L	5,580	N L	4,960	N L	4,490	N L
Sept.-----	6,000	L & W	6,700	L & W	5,000	N L	4,960	N L	4,760	N L	4,040	N L
Totals-----	92,210	-----	141,640	-----	93,610	-----	83,790	-----	88,910	-----	78,370	-----

In the above table the following letters designate the station at which the records were kept:

L—Laidlaw station.

W—Wimer canal.

B—Bend station.

NL—New Laidlaw station.

* During November and December, 1908, the records were kept at the Bend station so about 3,000 feet that was run into the Columbia Southern and Wimer canals were lost from the

records; the above record contains this additional amount. During April, 1909, and March, 1911, there were no readings recorded, so for those months conservative average figures have been used to complete the records. During November and December, 1909, the largest continued flood ever known on Tumalo Creek took place and continued throughout the winter. The gaging stations were washed away, thus the records were lost for these months, but for a basis of completing the above table the flow of November and December, 1906, was used, although it is known that more water run off in 1909. Some water was also lost from the record in November and December, 1907 and 1910, on account of water turned into the Columbia Southern and Wimer canals, when the record was kept at the Bend station, but the amounts were undoubtedly small so no account was taken of them in the above table.

From the foregoing it is plainly evident that the irrigation year from October 1, 1910, to October 1, 1911, is the lowest year on record in seven years, including the season 1905. For the year 1910-1911, however, the recorded flow of 78,370, acre feet is obtained as shown, from the New Laidlaw and Bend stations. To obtain the flow of the creek at the intake location of the new Feed canal, it will be necessary to make certain corrections for the months of April to September, inclusive. As the winter flow from October to March inclusive was obtained at the Bend station located about one mile above the new intake location, there would be only a very slight increase in the flow, so that will be neglected as it is on the side of safety.

II. INCREASED DRAINAGE AREA OF TUMALO CREEK.

There are several methods that can be used to determine approximately the increase in the available water supply, due to the increased drainage below the New Laidlaw station. 1st, by comparison with the drainage area of Tumalo Creek; 2nd, by comparison with drainage areas in the immediate vicinity; 3rd, by direct comparison in increase of stream flow between the New Laidlaw station and the Bend station by a series of simultaneous measurements. These three methods will be discussed briefly in the following paragraph:

1st. The drainage area of Tumalo Creek at the New Laidlaw Station is estimated at 45 square miles, and the annual minimum run off for season 1910-1911 is recorded at 78,370 acre feet, which is equivalent to 1,742 acre feet per square mile, or about 33 inches for the entire drainage area. The

precipitation at Bend is about 16 inches per annum, so the precipitation of the 10 square mile area would be slightly in excess of that or about 20 inches. The precipitation of the Tumalo Creek area would range between 24 and 86 inches with a probable average of 60 inches. The areas are very similar in character, so from the recorded run-off of the portion above the New Laidlaw Station of 33 inches, we obtain a run-off of 11 inches from the lower 10 square miles by direct comparison of precipitation, which is equivalent to 5,800 acre feet per annum for a low year. This is only an increase of 7.40%, whereas the drainage area is increased 22.22%.

2nd. From the recorded run-off of the Deschutes River at Benham Falls we find that the flow amounts to 15 inches for a drainage area of 1,480 square miles, which would compare favorably with the lower portion of Tumalo Creek. At this same rate of run-off the flow from the 10 square miles of increased area of Tumalo Creek would be estimated at 7,000 acre feet.

3rd. For the spring and early summer months, namely: April, May and June, a direct computation can be made from actual measurements, made by the United States Geological Survey in 1907 and 1908, on the Tumalo Creek at the Laidlaw and Bend Station. These measurements were made in such a manner that we may consider them as simultaneous.

Date	Station	Discharge
MEASUREMENT NO. 1.		
April 14, 1907	Laidlaw (old)	120 c. f. s.
April 15, 1907	Bend	148 c. f. s.
April 14, 1907	Wimer Canal	22 c. f. s.
April 14, 1907	Columbia Southern Canal	46 c. f. s.
MEASUREMENT NO. 2.		
May 3, 1907	Laidlaw (old)	142 c. f. s.
May 4, 1907	Bend	108 c. f. s.
May 3, 1907	Wimer Canal	23 c. f. s.
May 5, 1907	Columbia Southern Canal	52 c. f. s.
MEASUREMENT NO. 3.		
April 1, 1908	Laidlaw (old)	69 c. f. s.
April 1, 1908	Laidlaw (new)	92 c. f. s.
April 1, 1908	Bend	46 c. f. s.
April 1, 1908	Wimer Canal	24 c. f. s.
April 1, 1908	Columbia Southern Canal	62 c. f. s.
MEASUREMENT NO. 4.		
June 23, 1908	Laidlaw (new)	176 c. f. s.
June 23, 1908	Bend	62 c. f. s.
June 24, 1908	Wimer Canal	26 c. f. s.
June 23, 1908	Columbia Southern Canal	93 c. f. s.

From the above measurements the following deductions have been made:

TOTAL FLOW OF TUMALO CREEK INCLUDING DIVERSIONS.

Date	Laidlaw stations	Bend station	Increase c. f. s.	Per cent
April 14, 1907 -----	142 c. f. s.	216 c. f. s.	74	52
May 3, 1907 -----	165 c. f. s.	183 c. f. s.	18	11
April 1, 1908 -----	92 c. f. s.	132 c. f. s.	40	43
June 23, 1908 -----	176 c. f. s.	181 c. f. s.	5	3

This shows quite clearly that during the early spring months the inflow below the upper station is quite large, decreasing in May and June, due to the fact that the run-off from the snow and rain on the lower part of the drainage area takes place during the early months. These four measurements cover a period of nearly three months, from April 1st to June 23rd, and the percentage of increase varies from 43% and 50% in April to 11% for May and 3% in June. These measurements give averages of increase of 38% for April, 91½% in May and 41⅓% for June, or applied to the flow for 1911 would net 2,155 A. F. for April, 783 A. F. for May and 689 A. F. for June, or a total of 3,627 A. F. Inasmuch as there is a very slight chance of increase during the remaining summer months, and as the winter flow was obtained from the Bend Station, this estimate of 3,627 acre feet should be conservative when compared to the probable increase for the entire annual run-off as estimated by the 1st and 2nd methods.

3. CRATER CREEK, LITTLE CRATER CREEK, ETC.

The water of Crater Creek and Little Crater Creek, which have their sources from glaciers on the top of Broken Top Mountain, can be diverted into the Tumalo Creek drainage basin by a canal or conduit with comparatively slight cost. Broken Top Mountain has an elevation of about 8,500 feet above sea level. The drainage area of Crater Creek and Little Crater Creek, including the two glaciers and the perpetual snow line above our canal location, is about six square miles and to divert this water will require a canal about 8,000 feet in length.

From the records of the Climatological Bureau of the Government the precipitation at the top of the Cascade Mountains is estimated at about 86 inches per annum. A precipitation of 86 inches over an area of six square miles would furnish 27,600 A. F., and estimating that about one-half of this pre-

cipitation would appear as run-off, there would be available from this source about 13,800 A. F. The drainage area is very rocky and a very small amount of surface soil covers the area, so except for evaporation there will be very small losses, and the run-off should exceed 50% of the precipitation.

On August 4, 1910, Mr. Fred N. Wallace, irrigation manager at Laidlaw, accompanied by several other men made a trip into the mountains to examine these sources of water supply around Broken Top Mountain. He reported that in Crater Creek alone at that time there was about 15 c. f. s. available and that in Little Crater Creek there was a little in excess of that amount available making a total of over 30 c. f. s.

I made the investigation of Crater Creek and Little Crater Creek on the 17th and 18th of September, 1910. At this time it was already quite cold upon the mountain, snow falling for about three hours during our visit there. There is one decided advantage over this source of water supply, inasmuch that the warmer the weather the larger the run-off, due to the melting of the ice at the top of the mountain. On September 18th, early in the morning the flow in these two creeks, during very cold weather was about 11 c. f. s. It increased toward noon to about 15 c. f. s. As the source of Tumalo Creek is of practically the same nature as those of Crater Creek and Little Crater Creeks, the flow throughout the year except during the spring freshet months, would be very similar as to the percentage of flow during each month. There is some possibility of Crater Creek and Little Crater Creek flowing more in proportion during the real hot weather. Using the flow of Tumalo Creek during the normal low year as a criterion, and with the flow of Crater Creek and Little Crater Creek on August 4th and September 18th as a guide, I have prepared the following estimate of the probable run-off of these two creeks during a normal low year:

ESTIMATED FLOW OF CRATER AND LITTLE CRATER CREEKS
NORMAL LOW YEAR FLOW.

<i>Month.</i>	<i>C. F. S.</i>	<i>Acre Feet.</i>
October	10	600
November	5	300
December	5	300
January	5	300
February	10	600
March	20	1200
April	25	1500
May	30	1800
June	35	2100
July	35	2100
August	25	1500
September	15	900
Total acre feet		13200

ESTIMATED FLOW OF CRATER AND LITTLE CRATER CREEKS
NORMAL LOW YEAR FLOW.

The winter flow of Crater Creek may be lost in whole or part due to freezing conditions, but I estimate this would not amount to more than 1500 A. F. as the flow is at a minimum during the winter.

With the duty of water at 1.8 acre feet (22 inches) net on the ground, as set forth in your contract with the State, allowing 25% loss due to the distribution system, 6% to the reservoir, and 7% to the feed canal, the gross amount necessary at the headgate for one acre would be about 2.70 acre feet. Applying the duty to the water available from Crater Creek, Little Crater Creek, etc., we find there is sufficient for about 5,000 acres.

Applications for permits to use the waters of Crater Creek, Little Crater Creek and three small springs up to 50 c. f. s. continuous flow have been filed with the State Engineer, as well as application for the construction of a reservoir for storage purposes. These applications were number 952 and 953 respectively, and were received September 9, 1910, at 8:00 o'clock A. M. at the office of the State Engineer, who under date of February 27, 1911, issued a permit to use the waters provided construction was commenced on or before February 27, 1912, continued with diligence and completed on or before February 27, 1915. Under date of February 27, 1912, a report was made to the State Engineer that actual construction was commenced on February 20, 1912, so that we have a good prior right to these waters at the present time.

4. RUN-OFF FROM TUMALO RESERVOIR BASIN.

The drainage area of the Tumalo Reservoir is separate from that of Tumalo Creek, comprising about 25 square miles. The only continuous flow of water at the present time is Bull Creek Spring, which flows uniformly about 2 c. f. s., from one corner of the basin. The annual precipitation varies from about 16 inches at the lower end to about 30 or 40 inches in the higher altitudes, coming for the most part in the winter time in the form of snow. The average precipitation would probably exceed 20 inches. The run-off from the basin occurs in the late winter or early spring months, as the result of melting snow. As the greater portion of the area is covered with surface soil and vegetation the run-off would be small in comparison with precipitation. When Tumalo Dam is built, however, any seepage that would find its way to the lower eleva-

tions would be stopped. The proposed reservoir covers 1405 acres, so that direct precipitation on the water surface area of 16 inches would be saved. It is also safe to assume that the run-off from the 25 square mile area would at least be four inches or one-fifth of the average precipitation, especially when the run-off from the adjacent drainage area of Tumalo Creek by actual measurement record is 33 inches, and the Deschutes River by measurement at Benham Falls is 15 inches. A run-off of four inches over the 25 square miles would amount to 5333 acre feet. The increase in the annual water supply therefore from this source would be estimated as follows:

Bull Creek Spring, 2 c. f. s.	1450 acre feet
Precipitation of 16 inches on reservoir	1320 acre feet
Run-off from 25 square miles	5330 acre feet
Total	8100 acre feet

SUMMARY OF WATER SUPPLY.

As set forth in Exhibit No. 1, the amount of water necessary for irrigation has been determined at 1.8 acre feet per annum net at delivery points. Considering the nature of the crops, soil, length of irrigation season, the cool nights, etc., I believe this amount sufficient and adequate. Until the entire area under the project is under cultivation, while the constructed canals are new and the economical use of water is understood, the loss in the distribution system is liable to be large, so accordingly they have been estimated herein at 25% of the net amount to be delivered. The loss in the proposed New Tumalo Feed Canal of 300 c. f. s. capacity, has been estimated at one per cent per mile or 7% of the total amount diverted at the creek. The losses at the reservoir although uncertain are expected to be small, because it is entirely surrounded by solid rock. The evaporation has been estimated as 48 inches per annum or four inches per month for the average monthly water surface area, or 3970 acre feet. In addition 2700 acre feet have been estimated as a probable loss due to interference of ice on the Tumalo Feed Canal, while 1500 acre feet has been estimated as the loss for the same cause on the Broken Top Diversion of Crater Creek. There may be some loss at the Diversion Dam on Tumalo Creek due to limited capacity of the canal. The Wimer Ditch, which at the present time supplies water to lands in the vicinity of the reservoir can be purchased in connection with the lands needed for the reservoir. This ditch with very little work could be put in good condition to carry 50 c. f. s., so with the New Tumalo Feed Canal, capacity 300 c. f. s., the maximum diversion capacity would

be 350 c. f. s. For the seasons of record on Tumalo Creek the amount that would be lost due to the limited capacity is as follows: Year and acre feet wasted above 350 capacity: 1906, 305; 1907, 3,201; 1908, 1,243; 1909, 288; 1910, 0; 1911, 264.

It will be noticed that for the years of low record the loss is correspondingly much less due to the capacity of the canals. This will be slightly increased, however, when supplemented by the flow of Crater Creek. For instance, for season 1911, the low year, the loss for Tumalo Creek alone is 264 acre feet, which would be increased to 608 acre feet when the estimated flow of Crater Creek is added to the peak of the flood. There may also be a slight loss due to the increased length of the Wimer Canal over the new feed canal, but on account of being used only during the irrigation season of six months, and then only in quantities ranging from 10 to 50 c. f. s., the loss could not exceed 1000 acre feet.

The amount of water available from the various sources may be tabulated as follows, estimated for 1911, the lowest year of record:

	<i>Acre Feet.</i>
Tumalo Creek as recorded	78,370
Increase of 10 square miles' area	3,630
Crater Creek, Little Crater Creek, etc.	13,200
Bull Creek Spring	1,450
Precipitation of 16 inches on reservoir area	1,320
Run-off reservoir basin 25 square miles	5,330
Total	103,300

The irrigation requirements and losses may be tabulated as follows on a basis of 35,000 acres of irrigable land:

Requirements net on ground 1.8 'a. f. per acre	63,000
25 per cent loss on distribution system	15,750
Evaporation and reservoir losses	3,970
Loss due to ice on feed canal	2,700
Loss due to limited capacity of 350 c. f. s.	610
Loss due to ice on Broken Top Division	1,500
Loss in Wimer Canal on account of additional length	1,000
Loss in feed canals at 7 per cent gross diverted	6,230
Total	94,760

From the above two tabulations it would appear that there is sufficient water available for a total of 35,000 acres, with a surplus of 8,540 acre feet remaining. The year 1911 is the lowest of record in seven years, so it is very safe to base the calculations on that year, and should there appear a lower year once in 10 or 12, we have a surplus of over 8,000 acre feet which can be used to carry over.

The irrigation season has been set from April 15th to October 15th each year. From the various sources above tabulated

there would be available from October 15 to April 15, 1910-1911 for storage the following amounts:

	<i>Acre Feet.</i>
Tumalo Creek	31,720
Crater Creek, etc.	3,750
Bull Creek Spring	725
Run-off from reservoir basin	5,330
Precipitation on reservoir area	1,870
Total	43,395

The following losses are estimated for the same period as above:

	<i>Acre Feet.</i>
One-half evaporation on reservoir	1,960
Loss due to ice on feed canal	2,700
Loss due to ice on Broken Top Division	1,500
Loss in feed canal, 7 per cent gross flow	2,600
Total	8,760

The difference between 43,395 and 8,760 or 34,635 acre feet, is then available for storage during the non-irrigating season. The following tabulation of the water supply losses and irrigation requirements shows that with the water supply as computed and the total reservoir capacity at 32,218 acre feet, there would be still available 4,980 acre feet as a surplus in the reservoir at the close of the irrigation season. There would also be a surplus of 3,395 acre feet that would be lost due to limited capacity of the reservoir over and above the irrigation requirements.

HYDROGRAPHIC TABLE, SEASON 1910-1911. Figures in Acre Feet.

Year 1910-1911. Month	Losses				Delivery into reservoir					Average area of water surface in reservoir—acres	Estimated loss in reservoir by evaporation	Amount available at head of lateral system and reservoir	Irrigation requirements 1 A. F. net on ground plus 25 per cent for distribution for 35,000 acres	Amount in reservoir at the close of each monthly period, maximum capacity 32,218 A. F.	Surplus to waste
	Interference with ice		Seepage, etc., in canals		By feed canals (net)	By Bull Creek Spring	By runoff from reservoir basin	By precipitation on the actual water surface area	By all combined sources (totals)						
Oct. 16-31					2,613	60	265	10	2,948	140	47	2,901		2,901	
Nov.					3,683	120	530	80	4,413	375	125	4,288		7,189	
Dec.					5,831	120	900	110	6,861	620	207	6,654		13,843	
Jan.					3,962	120	1,065	183	5,335	910	303	5,032		18,275	
Feb.					4,222	120	1,340	224	5,906	1,135	378	5,528		24,403	
March ..					5,847	125	1,330	247	7,549	1,305	434	7,115		31,518	
April ...					8,440	125	---	97	8,662	1,405	468	8,194	5,400	32,218	2,094
May					9,972	120	---	111	10,203	1,405	468	9,735	10,700	31,253	---
June					16,629	120	---	135	16,884	1,405	468	16,416	14,350	32,218	1,101
July					9,728	120	---	61	9,909	1,308	434	9,475	17,900	23,793	---
August ..					5,282	120	---	28	5,430	950	317	5,113	17,900	11,006	---
Sept.					4,501	120	---	24	4,645	570	190	4,455	9,000	6,461	---
Oct. 1-15					2,083	60	---	8	2,151	400	133	2,018	3,500	4,979	4,979
Totals ..					82,738	1,450	5,330	1,323	90,806	---	3,972	86,924	78,750	---	8,174

Inasmuch as the computations in the table are based on the low year record 1910-1911, and there appears to be a surplus of 4,980 acre feet in the reservoir at the close of the irrigation season, it hardly seems advisable to increase the storage capacity, for the only benefit that could be obtained would be a larger surplus which probably would not be needed the following season. The surplus of 3,395 acre feet may also be considered as an additional factor of safety over the estimated losses in feed canal and reservoir. The minimum reservoir capacity required as per the table to serve 35,000 acres would be 32,218 less 4,979—or 27,239 acre feet. In our plans and estimates, however, the capacity of 32,218 acre feet has been used.

The duty of water at 1.80 acre feet net on the ground is approximately 22 inches. In the above hydrographic table the irrigation requirements have been based on the following use of water on a basis of 35,000 acres of irrigable land, after a careful study of the conditions on the ground and the probable distribution during the irrigation season from April 15 to October 15.

The following table is for inches on ground and acre feet for 35,000 acres (1.8 acre feet plus 25 per cent for loss per acre):

<i>Month.</i>	<i>Inches.</i>	<i>Acre Feet.</i>
April 15-30	1½	5,400
May	3	10,700
June	4	14,350
July	5	17,900
August	5	17,900
September	2½	9,000
October 1-15	1	3,500
Totals	22	78,750

In the above computations, for the capacity of the reservoir and of the amount of water available, the winter flow of the creek was considered after making deductions for loss through interference with ice. In the present constructed main canal of the Columbia Southern Project it is impossible to run water in the coldest part of the winter for the reason that the head-gate is located in the mountains at an increased elevation of 1,000 feet, and the canal is so poorly constructed that trouble might arise. In a canal designed as the new feed canal, there should be no difficulty in that climate to divert the water in the winter. Usually each winter there is a short period of cold weather, rarely exceeding 30 days, during which time sufficient ditch walkers should be maintained to keep the ice on the move and wasted at the different waste ways provided.

Over a large portion of the segregation water for stock and domestic purposes can be obtained from wells, and this will

no doubt be possible in nearly all localities after irrigation has been carried on more extensively than at the present time. In the meantime water can be filtered and stored in cisterns or reservoirs, which has been done to some extent in a few places previous to this time.

In the report which Mr. D. C. Henny, consulting engineer, rendered on this project under date of August 11, 1910, he used the flow of 1909 of Tumalo Creek as his criterion for determining the number of acres that could be irrigated. At the time his report was written the records for 1909, 1910 and 1911 had not been published by the Geological Survey, so the flow for 1909 was estimated from the available gauge heights and data at hand. His estimate for 1909 and the published record as now herein contained do not vary materially. The records for 1909 as used by Mr. Henny are incomplete, but with certain safe assumptions he concluded that there was sufficient water to irrigate 30,000 acres and he still had a surplus of 4,800 acre feet. The unusual low flow of November and December, 1908, has been investigated and it has been found that the Columbia Southern and Wimer canals both run considerable water during these two months, which was not included in the government record which was obtained from the Bend station. This is also true concerning the record of November, 1907. Taking the low flow for the winter months from October to March, 1907-1908 and from October to March, 1908-1909, and comparing them, it is evident that about 3,000 A. F. was lost in the record for November and December, 1908, especially when corroborated by Mr. Fred N. Wallace, the irrigation manager of the Columbia Southern canal and Mr. Geo. W. Wimer of the Wimer canal. In his report Mr. Henny took no account of the flow of Bull Creek Spring, which flows into Tumalo Reservoir, which flows about 1500 A. F. per annum. Taking the surplus water according to Mr. Henny's report as 4,800 A. F., the amount lost in government record of November and December, 1908, at 3000 A. F., the flow of Bull Creek Spring at 1500 A. F., and the estimated amount of 13,200 A. F., from Crater and Little Crater Creeks, we have a total of 21,700 A. F. over and above the requirements as estimated by Mr. Henny for 30,000 acres, in his report dated August 11, 1910. A copy of Mr. Henny's report is attached hereto, marked exhibit number 7.

PROPOSED WORKS.

The irrigation project as proposed herein involves the rebuilding of the entire Columbia Southern Project, which will

consist of the building of the Broken Top Diversion Canal, the enlargement of the Wimer Ditch, the construction of the New Tumalo Feed Canal, complete storage works and a complete distribution system to water 35,000 acres of land. These works will be built according to the standard designs and according to the best up-to-date methods of construction. Complete plans, specifications and estimates accompany this report. They have been prepared with great care after considerable work and deliberation.

BROKEN TOP DIVERSION CANAL.

The location of this canal is about 25 miles southwest of Laidlaw, near Broken Top Mountain, and its object is to divert the flow of Crater Creek, Little Crater Creek, and various springs into the drainage area of Tumalo Creek. The weather at Broken Top Mountain is such that this work must be done in the middle of summer. The months of June, July, August and September are most preferable, for during the remainder of the year rain and snow would delay the work to a considerable extent. This work should be done during the season 1912 or 1913 and simultaneous with it a record of the water available should be kept so the additional amount of land that it could serve could be correctly determined. In order to reach the canal location with equipment and supplies it will be necessary to build a trail from the old Columbia Southern Canal heading up into the mountains.

As this construction work will be quite remote from transportation and as it will be very difficult to get equipment and supplies on the ground, I have made very liberal allowances on these estimates, and have computed all excavations, etc., on a basis of hand work.

The capacity of the canal has been estimated at 50 cubic feet per second on a grade of one foot per 1000 (.001) so as to make the minimum section. The work involved in diverting these two creeks into the drainage area of Tumalo Creek should be done during the season of 1912. There will be approximately 3,000 feet that will be rather expensive work consisting of side-hill and some rock work. As some of the rock is of rather poor quality, it may be necessary to line a portion of this with a thin layer of concrete. That portion which will be lined will probably cost about \$6.00 per foot including the lining, but the total of 3,000 feet I have estimated at \$4.50 per foot. About 2,000 feet will be through earth and gravel thorough cut, the maximum cut being about 12 feet and averaging about eight feet. This portion I have estimated at \$2.00 per

foot. The remaining 3,000 feet will be comparatively easy canal work less than one yard to the foot, which I have estimated at 60 cents per lineal foot. I have estimated also on four small concrete headings at the diversion points of Crater Creek, Little Crater Creek and two springs. A waste way or two will also be necessary to limit the flow of water in the canal in case of an excessive flood that may occur.

ENLARGEMENT OF WIMER DITCH.

The Wimer ditch is owned and used at the present time by Geo. W. Wimer and Sons, who own 600 acres of land within the limits of the proposed reservoir; P. A. Woolley, who owns 320 acres in the reservoir, and L. J. Wimer and C. H. Spaugh who own 480 acres adjoining the reservoir. Arrangements have been made for the purchase of these lands including all water rights and the ditch. The subject of these land purchases will be more fully taken up under the subject of storage works. The ditch is at the present time in fair condition and will with a few repairs, alterations and enlargements be able to maintain a flow of 50 c. f. s. This ditch is valuable in connection with the feed canal in supplying the reservoir, especially during the flood period. It could also be used in connection with the irrigation of about 2,000 acres of fine land which lie above the high water elevation of the reservoir. I estimate that about \$5,000.00 would be necessary to repair and enlarge this Wimer ditch.

FEED CANAL.

The new feed canal has been located throughout its entire length on the ground. The intake is situated on Tumalo Creek near the center of Section 23, Township 17 South, Range 11 East, about eight miles below the intake of the old Columbia Southern canal and about two miles from the mouth of the Tumalo Creek. The feed canal is about seven miles in length and located throughout its entire length in the township above mentioned; the drop into the reservoir occurring near the $\frac{1}{4}$ corner of the north line of Section 4. In general, can say that the location of this canal is a very good one.

The first half mile of the canal is located in Tumalo Canyon on a shell rock and debris side hill. A bench will be excavated into the side hill and the canal will consist of a wooden flume built on sills upon the bench excavated. Flume also will be used for about one-half mile in Howard Canyon where the location of the canal falls just below the rim-rock. With the

exception of about 1,000 feet of solid rock thorough cut and two small draw crossings, the balance of the canal is located on nearly flat ground with level cuttings. Test pits have been dug along the entire length of the location, which show the exact nature of the material to be excavated. For the most part this excavation will consist of easy earth with some gravel and boulders, except for about 6,000 feet near the reservoir where the surface rock is quite thick and some cemented gravel will be encountered in the bottom of the canal.

The right of way for the feed canal is covered with vegetation. In Tumalo Canyon there is considerable brush for a short distance, but for the balance of the canal the growth consists of scattering pine, juniper and sage brush. The right of way for this canal can be purchased at a very reasonable figure; the ground ought to be cleared for about \$40.00 per acre.

The feed canal, including all sections, is designed to carry 300 c. f. s., but is capable 350 c. f. s. maximum flow. The canal as located will have a bottom width of 20 feet, side slopes 2 to 1, depth 4.75 feet with an allowance of two feet from the water surface to the top of the canal berm. The grade is .003 giving a velocity of 2.3 feet per second with an assumed value of "n" at .024. This grade and velocity ought to allow the silt to settle in the canal and form a tight canal and cause no washing of the banks. The economic cutting for the above section is about 3.4 feet and the above section was accordingly chosen on account of the fact that the test pits revealed cemented gravel in a great many places and solid rock in a few places at a depth between three and four feet. This canal is of sufficient size and enough quantities are involved to use a steam shovel or drag scrapers for the excavation, provided slip scrapers are used in distributing the material and tramping down the banks.

Flumes have been designed with an inside width of 10 feet and depth of water of five feet. The value of "n" has been assumed at .012 because rough lumber may be used for this construction. With a grade of .0007, the velocity is six feet per second. The lumber for the sides and bottoms of the flumes should be sized, and joints to insure tightness should be made in accordance with the detail on Drawing No. 9. There is an abundance of timber in the near vicinity of the project and by going far enough back into the hills, lumber of a good quality and sufficient quantities can be obtained. The price asked for lumber at the present time is about \$14 per thousand feet B. M. There will be enough lumber needed in the con-

struction of these flumes to warrant the company in putting in their own saw mill plant and in this way a sufficient amount of lumber could be obtained as needed at minimum cost.

Just before entering the Howard Canyon, a rock cut with maximum cut of 14 feet is encountered. It is approximately 1,000 feet long and an increase of grade over the earth section with a decrease bottom width is justifiable to decrease the quantities. This cut is made 18.4 feet wide on the bottom with side slopes of $\frac{1}{2}$ to 1, "n" being assumed at .035. At the lower end of this rock cut there is a drop in the grade of the canal of about 12 feet, so that the location of the flume in Howard Canyon will be below the rim-rock. This drop will consist of a concrete weir lip, placed on solid rock at the upper end and a water cushion basin excavated in solid rock at the lower end.

The drop into the reservoir from the feed canal will be about 400 feet long, and consist of a cut in solid rock excavated about 15 feet wide and three feet deep. A small basin may be excavated at the bottom of the drop so as to avoid cutting. This drop will be about 25 feet in height.

In order to eliminate outlet works at the auxiliary Bull Creek Dam and also to eliminate passing of water through the reservoir, a by-pass will be constructed from the feed canal to connect with the spillway channel of the Bull Creek Dam, thus delivering the water into the main canal below Bull Creek Dam. This by-pass need only be about 100 c. f. s. capacity. At the end of the by-pass above the spillway channel a small concrete weir lip will be placed to maintain the slope of the water as designed for the by-pass.

The diversion dam or weir on Tumalo Creek is designed to be built of concrete. It is designed to accommodate a flow of 350 c. f. s. into the canal, and in case of maximum high water of the creek, will satisfactorily take care of about 1,500 c. f. s. or about two times the maximum high water and three times the normal high water of Tumalo Creek. The first 500 feet of canal from the diversion weir will be in earth from which point the flume will commence. At the beginning of the flume in Tumalo Canyon a waste-way will be provided to handle any surplus water diverted into the canal. Such waste-ways will also be located at the Tewksbury and Howard Canyon flume crossing, in order to be able to easily dispose of floating ice during the winter season.

Completed specifications covering the work involved on the feed canal will be found in Exhibit No. 3.

Photographs showing the intake of the canal on Tumalo Creek, Tumalo Canyon, the Tewksbury and Howard Canyon

flume crossings, the drop in the reservoir, the drop in solid rock, and a typical view of the canal locations in earth, are shown in Exhibit No. 4.

STORAGE WORKS.

One reservoir is planned in connection with the project which I have named Tumalo Reservoir on account of the fact that Tumalo post-office is located at the present time in the reservoir basin which has been known up to this time as Wimer Flat. The reservoir is located about five miles due west of Laidlaw in Sections 4 and 5, Township 17 South, and Sections 29, 30, 31, 32 and 33, Township 16 South, all in Range 11 East. The natural conditions are very favorable for a storage reservoir, the site being surrounded by solid rock formation which is at least three-quarters of a mile thick, with the exception of two gaps which will be closed by Tumalo and Bull Creek dams. Even at the dam sites, nature has done her part by providing solid rock ledges which outcrop on the sides and are close to the surface at the bottom. Test pits have been sunk at both dam sites uncovered the bedrock, so there is no doubt about the depth of the surface soil. The test pits are shown on Drawings No. 6 and 7.

The proposed capacity of the reservoir is 32,200 acre feet, which has been obtained from a capacity curve, Drawing No. 5. The total area of the reservoir submerged will be 1,405 acres. Between elevations 3,500 and 3,505 in the upper part of the reservoir there is a depression covering 127 acres and containing 450 acre feet which will be drained by a cut as shown on drawing No. 3. The approximate cost of this cut is \$500.00.

Within the reservoir there are 920 acres of land owned by Geo. W. Wimer and Sons and P. A. Wooley, which have a water right from Tumalo Creek carried through what is called the Wimer Ditch. Arrangements have been made for the satisfactory purchase of this land and water rights.

In order to obtain possession of the Wimer Canal and all water rights under same it is advisable to purchase 480 acres of land which lie a short distance east of the reservoir and are owned by L. J. Wimer and C. H. Spaugh. About 120 acres of the Geo. W. Wimer lands will not be flooded by the reservoir, and this together with the 480 acres of Wimer and Spaugh could be easily resold with water rights. The lands owned by Geo. W. Wimer and Sons, P. A. Wooley, and Wimer and Spaugh will cost \$66,000.00.

The balance of the lands in the reservoir are unimproved and can be bought for about \$14,000.00. They are covered

with a thick growth of sage brush, so there will be no necessity of clearing or grubbing within the reservoir. The ownership of the lands within the reservoir is shown on Map No. 13.

At the present time there is about five miles of county road within the limits of the reservoir, which will have to be provided for before the actual storage of water takes place. This will be accomplished by locating the roads on the east side of the reservoir, crossing both of the complete dams and involves about three miles of road constructions which will cost about \$1,200.00. The dwelling houses and barns owned at the present time by P. A. Wooley and Geo. W. Wimer and Sons can be very economically used during the construction of the two dams as construction camps.

The borrow pits for both the dams are located within the reservoir showing the character of the material in the bottom of same. The reservoir being underlaid and surrounded by solid rock, the probabilities are that there will be no appreciable losses from the reservoir except by evaporation which ought not to exceed 48 inches per annum.

TUMALO DAM AND OUTLET WORKS.

The main storage dam is called Tumalo Dam. It is located in the canyon at the lower end of Wimer Flat about $1\frac{3}{4}$ miles north of Tumalo post-office. Bull Creek dam is situated about two miles southeast of Tumalo dam and about one mile east of Tumalo post-office, and is called the auxiliary dam. Tumalo dam is about 400 feet long on top and about 20 feet wide. It will be built to a top elevation of 3,526.50 with a 3 to 1 upper slope and a 2 to 1 lower slope. The maximum fill will be about 80 feet and the total contents about 109,000 cubic yards. This dam will have a concrete core-wall extending from the solid bed rock on the bottom to an elevation of 3,522 or two feet above the spillway elevation. It will be five feet wide on top and approximately ten feet wide on the bottom as shown on Drawing No. 6. The complete core-wall as planned will contain approximately 5,100 cubic yards of concrete. This core-wall is designed very safe and an alternate design has been proposed involving steel reinforcements and about one-half the quantity of concrete would reduce the cost of the core-wall about \$25,000.00. This alternate plan may be adopted after further investigation as to the water tightness of the material in the borrow pit and other information is obtained in regard to this particular class of concrete steel construction.

A cut-off trench will be excavated along the center line of the dam to bedrock, which will be refilled with water tight material

on both sides of the core-wall as shown on the plans. Along the lower toe of the dam a drain trench will be excavated to bedrock which will be refilled with loose rock. In the lower edge of this trench a line of drain tiling will be placed to carry off any water that may seep into the trench. The two slopes of the dam shall be covered for a thickness of three feet with a loose rock fill composed of rock of about one cubic foot in volume. Such excavation as is suitable, obtained from the outlet tunnel and gate shaft will be used for this riprap, and the balance of the rock shall be obtained from borrow pits opened up above the top of the dam on the sides of the canyon where rock of a suitable character is in abundance.

There are also two alternate plans for the construction of the dam embankment. The first method which is ordinarily used in earth fill dams, namely, that of depositing the material in six inch layers sprinkling and rolling, and assorting the material so as to place the water-tight material near the center of the dam. The nature of the material of which the dam embankment must be formed is of such character that this method would be very difficult to follow. The surface soil is very light and of such character that suitable water-tight material would be very difficult to separate. Gravel is there more or less abundant, scattered throughout the surface soil. The other method of building the dam embankment, and to me it appears the more feasible, is as follows:

All material should be dumped at or near the two slopes of the dam by dump wagons or dump cars, whichever may later be decided upon. The fine water-tight material may be then graded and washed into place by means of a stream of water from a nozzle under pressure. The material could be thus automatically separated so that the gravel and coarse material would lie next to the slopes, the fine gravel and coarse sand would next be deposited and the real fine sand and silt would be carried to the center of the dam and there deposited forming the water-tight portion of the dam. The approximate distribution of this material in the dam is shown on the section on Drawing No. 1. There is at the present time about one mile from the dam site at a suitable elevation to furnish the satisfactory pressure, a ditch of such capacity as to carry the required amount of water. I have estimated that about 2 c. f. s. should be sufficient to do this work.

The outlet works for Tumalo reservoir will be located at Tumalo dam. They will consist of a tunnel through the hillside in solid rock and a gate shaft, also through solid rock, from an elevation the same as that of the top of the dam, connecting with the tunnel. All of the gate shaft and the portion

of the tunnel up to and including the gate chamber will be lined with concrete. The thickness of this concrete lining will vary from 1 to 2 feet, depending upon the importance of the position. The concrete lining of the gate chamber and the gate shaft and also in the tunnel where necessary, shall be reinforced with steel bars. At the entrance to the tunnel a steel grillage will be placed to keep floating debris from entering the gates. The gates, gate rods and stands, will be accurately and substantially set in concrete, be perfectly aligned and in a free and easy working condition. A gate house of appropriate design will be constructed over the gate shaft.

BULL CREEK DAM AND SPILLWAY.

This dam will have a top width of 20 feet and be about 300 feet long on top. It will be constructed to an elevation of 3,526.50, have a maximum fill of about 30 feet and contain about 10,600 cubic feet of material. The side slopes will be 3 to 1 and 2 to 1 respectively on the upper and lower sides. Cut-off trenches and drain trenches will be excavated to bedrock as shown on the plans and be refilled in a manner described for Tumalo dam and in the specifications. Cut-off walls of concrete will be built in the cut-off trench to such heights as shown on the plans to prevent the water from following the bedrock and thus endanger the structure and cause leaks. A good connection will be made with the cut-off wall and the retaining wall which is to be placed at the end of the dam to form one side of the spillway. All solid rock excavated from the spillway and spillway channel will be placed in the dam embankment to form a three foot layer of loose rock on the upper side and to form the loose rock portion of the dam on the lower side, as shown on the plans. This portion of the embankment is estimated at 3,260 cubic yards.

The test pits sunk in the borrow pit for this dam show an abundance of good clayey material. We can, therefore, quite economically build this dam in the ordinary manner of earth filled dams, by depositing the material in thin layers, thoroughly sprinkling and rolling, the same as described in detail in the specifications. Water for sprinkling is available a short distance from the dam site in one of the Columbia Southern Irrigating Company's ditches.

The spillway for Tumalo reservoir is situated at Bull Creek dam. It will consist of rock excavation, forming a level bench at an elevation of 3,519 to the axis of the dam where a concrete weir lip 70 feet in length will be built to an elevation of 3,520. Below this weir lip a spillway channel will be excavated

through the solid rock, diverging from the 70 foot width at the crest to 20 feet wide 56 feet farther down, from which point the channel will be 20 feet wide on the bottom and with $\frac{1}{4}$ to 1 side slopes. The spillway channel will be excavated on a slope of 7 to 1. The bottom of the spillway channel will connect with the main canal below the Bull Creek dam. The excavation involved on the spillway is 4,235 cubic yards, most of which is solid rock.

The drainage area of Tumalo reservoir is estimated at 25 square miles. The only occasion for a spillway, as the water is diverted into the reservoir by means of the feed canal, is in case of a cloud burst, or an unusually heavy rain, when the reservoir should be full. The annual precipitation of this region being in the neighborhood of 16 inches, the run-off, if no account were taken of evaporation, would be from 12,000 to 17,000 acre feet. If all this precipitation and run-off should occur within a 15-day period, in place of being distributed throughout the whole year, the run-off would be only 530 c. f. s. The spillway is designed for a discharge capacity of 630 c. f. s. which ought to be very safe.

An alternate plan for the construction of the Bull Creek dam and spillway has been prepared, of a curved concrete steel type. This dam would be built only to the spillway elevation, heavily reinforced with steel, so as to make a spillway of the whole length of the dam. The total length of the dam on top would be 190 feet and about 100 feet at the bottom, with a maximum fill of 27 feet. For additional spillway length and to provide rock for concrete 110 feet could be excavated on the south end of the dam, thus making a total spillway of 300 feet. The estimates on this type of dam show the cost to be about the same as for the earth fill type so the estimates of the earth dam will be used.

DISTRIBUTION SYSTEM.

Nearly all of the main canals which were constructed by the old companies will be abandoned. Some of the laterals, however, that were constructed last are in such condition that they can be used when properly reconstructed and enlarged. The distribution system as planned will consist of about 140 miles of main canals and laterals, with the necessary structures, which includes about 65 miles of the old system that can be used after reconstruction.

The lands can be very easily divided into four irrigation districts: (1) The lands in the vicinity of the reservoir above the feed canal; (2) the lands irrigated direct from the feed canal; (3) the lands irrigated north of the reservoir, west of

Cline Buttes and in the vicinity of the lands known as the Squaw Creek segregation; and (4) the lands irrigated by the main canal which runs almost due east from the outlet of the reservoir.

The approximate amount of irrigable land in each separate district, with the capacities of the canals as planned, are as follows:

	<i>Acres.</i>	<i>Capacity c. f. s.</i>
Above feed canal	2,000	20
Feed canal	9,000	300
Main canal	20,000	180
North canal	6,000	50
Total	37,000	

Those lands which lie above the feed canal can be irrigated from the Wimer Canal by repairing and enlarging same as previously mentioned.

The lands under the head of North Main Canal are situated in Townships 15 and 16 South, Range 11 East, and border on Squaw Creek segregation.

The lands under the project are covered for the most part with juniper which must be removed before cultivation can take place. Loose surface rock is also plentiful in places, but where thick have been classified as waste land. The soil is rather light and washes quite readily so the side slopes of nearly all the canals will be 2 to 1. In some places where good lands of sufficient amount cannot be reached by canals, flumes will be built. All the structures are planned of wood.

The main canal and some of the laterals have been located on the ground. For others the critical points have been determined to make their locations feasible from the topographic map. Side hill construction has been avoided as much as possible on account of solid rock and flume work. To prevent cutting and insure tight canals, they are all located on flat grades; drops constructed of wood being designed to convey the water from a higher to a lower level where necessary.

The sizes of the various canals and laterals will vary from 2 to 15 feet in bottom width, from 1 to 5 feet in depth, and from 5 to 180 c. f. s. in capacity. As the rotation method of delivering water for irrigation seems to be gaining favor generally and may be applied to the project, the smallest laterals estimated are 5 c. f. s. capacity. The distribution of water is estimated at each man's holdings, in tracts not larger than 160 acres and no smaller than 40.

Drawing No. 1 shows a topographic map of the State segregated land under the project and Drawing No 2 shows the distribution system as designed, with the size of the canals

and laterals. Drawing No. 2 also shows the waste land and lands too high to irrigate.

ESTIMATES.

The following includes estimates for the construction of the entire project, prepared after a thorough investigation of conditions as they exist on the ground. The prices of materials and plant were obtained by inquiry at Portland, and the transportation charges included in the estimates. All the unit prices are conservative and would include actual cost plus contractors' earnings. All land purchases under the Wimer Ditch are included under cost of storage works. After construction is commenced it is intended to establish a central office at Portland, Oregon, and also a field office at Laidlaw, Oregon, so that land sales will be made directly through these offices by men in the company employ. Therefore these estimates do not provide for any additional cost in the form of commissions, but the expense will be included under administration charges. If the land sales are effected through a special agency the administration charges will be slightly decreased, and special provisions should then be made to cover land sales or commissions. The estimates will be taken up in the order as discussed above.

BROKEN TOP DIVERSION CANAL.

(Crater Creek, Little Crater Creek, etc.)

3000 feet of canal at \$4.50 per lineal foot.....	\$13,500.00
2000 feet of canal at 2.00 per lineal foot.....	4,000.00
3000 feet of canal at .60 per lineal foot.....	1,800.00
Concrete headings at diversion points and wasteways.....	3,000.00
Building and clearing trail	800.00
Total	\$23,100.00

ENLARGEMENT OF THE WIMER CANAL.

This has been estimated at\$ 5,000.00

ESTIMATE ON FEED CANAL.

Diversion weir	\$ 5,000.00
Flumes, 6000 feet at \$5.25	31,500.00
Trestles, 1000 feet at \$2.00	2,000.00
Excavation for flumes, 5000 lin. ft., 7500 cu. yds. at 40c....	3,000.00
Canal excavation, 8100 lineal feet of canal—	
18,400 cubic yards at \$1.25	23,000.00
13,500 cubic yards at .50	6,750.00
23,600 lineal feet, 70,800 cubic yards at 30c.....	21,240.00
Right of way—	
Cost of land, about 80 acres	1,600.00
Clearing right of way	3,200.00
By-pass and drop into reservoir	3,000.00
Construction cost of feed canal	\$100,290.00

ESTIMATE ON TUMALO DAM.

Estimate on earth fill: plant—

Steam shovel (25 ton), capacity one cubic yard	\$ 9,000.00
25 dump wagons, capacity two cubic yards, at \$130.....	3,250.00
Ditch for puddling water	1,000.00
Pipe and pipe connections: 2000 feet 8-inch No. 10 steel riveted pipe, 1000 feet 6-inch No. 10 steel riveted pipe, 4 giants, pipe connections	1,000.00
Constructing trestles, dumping platforms, labor and material	2,000.00
Miscellaneous supplies, shovels, picks, hammers, tools, blacksmith outfit and supplies, harness, single and double-trees, etc.	2,000.00
Building roads at the dam	500.00
Total	\$18,750.00

Price per cubic yard for plant 20.42¢

Labor—

1 foreman at \$5.00	\$ 5.00
2 men on steam shovel at \$4.50	9.00
2 laborers on steam shovel at \$2.25	4.50
25 4-horse teams with teamsters at \$8.00	200.00
1 giant man at \$3.00	3.00
2 muckers at \$2.25	4.50
2 carpenters at \$4.00	8.00
1 blacksmith at \$4.00	4.00

Daily cost of operation \$ 237.00

Average daily output, 600 cubic yards.

Average cost per cubic yard 39.50¢

Total cost per cubic yard 59.92¢

Estimate on concrete—

Cement per bbl. (1 bbl. to 1 cubic yard).....	\$ 4.80
Mixing, labor, per cubic yard80
Placing, labor, per cubic yard70
Plant, cost per cubic yard	1.90
Sand and gravel per cubic yard	2.00
Forms, per cubic yard60
Water, per cubic yard20

Total cost per cubic yard \$ 11.00

Estimate on dam—

91,800 cubic yards earth excavation and fill at 60¢.....	\$ 55,080.00
5,100 cubic yards concrete core at \$11.00	56,100.00
2,550 cubic yards excavation cut-off trench at \$1.25..	3,187.50
2,200 cubic yards excavation drain trench at \$1.00.....	2,200.00
2½ acres stripping at \$300.00	750.00
12,100 cubic yards riprap at \$1.75	21,175.00
1,500 cu. yds. excavation for tunnel open cut at \$1.50 ..	2,250.00
400 feet excavation tunnel, 8x8 ft. at \$20.00	8,000.00
200 feet concrete lining, 300 cubic yards at \$18.00.....	5,400.00
70 feet shaft excavation, 14x14 ft. at \$40.00	2,800.00
75 feet concrete lining, 375 cubic yards at \$18.00.....	6,750.00
2 gates, rods, stands, grillings, etc., in place	5,000.00
1 gate house	1,000.00

Construction cost Tumalo dam \$169,692.50

ESTIMATE ON BULL CREEK DAM.

Preparing dam site	\$ 150.00
Excavation for cut-off and drain trenches—	
600 cubic yards at \$1.00	750.00
900 cubic yards at .60	540.00
Concrete cut-off walls, 650 cubic yards at \$11.00	7,150.00
Spillway excavation, 4235 cubic yards at \$1.00	4,235.00
Concrete on spillway, 100 cubic yards at \$15.00	1,500.00
Dam embankment—	
6700 cubic yards earth fill at \$0.40	2,680.00
3260 cubic yards loose rock at 1.00	3,260.00
Estimate of construction	\$ 20,265.00

ESTIMATE ON DISTRIBUTION SYSTEM.

Excavation and flumes, 35,000 acres at \$5.50	\$192,500.00
Structures, 35,000 acres at \$1.00	35,000.00
	<u>\$227,500.00</u>
Value of present system	45,000.00
Construction cost of distribution system	<u>\$182,500.00</u>

SUMMARY OF TOTAL COST.

Construction—	
Broken Top Diversion canal	\$ 23,100.00
Enlargement of Wimer canal	5,000.00
Feed canal	100,290.00
Reservoir roads and excavation of cut	1,700.00
Tumalo dam	169,692.00
Bull Creek dam	20,265.00
Distribution system	<u>182,500.00</u>
Total construction	<u>\$502,547.00</u>
Engineering, contingencies, incidentals, administration, etc., 15 per cent	\$ 75,382.00
Land purchases necessary for reservoir, etc.	80,000.00
Advertising for sale of lands	35,000.00
Preliminary investigation, surveys, engineers, lawyers, etc.	40,000.00
Amount to be refunded contract holders under segrega- tion, about	<u>85,000.00</u>
Total cost for 35,000 acres (at \$23.37 per acre)....	<u>\$817,829.00</u>

NOTE.—The last two items of \$40,000.00 and \$85,000.00 will be paid by an issue of preferred stock in the new reorganized company, and will be discussed further in a following paragraph.

RETURNS FROM LAND SALES.

As previously mentioned 31,700 acres under the project are withdrawn from entry under the terms of the Carey Act. Of this amount 24,000 acres are classed as irrigable, which leaves a balance of 11,000 acres of land in private ownership to be supplied with water on the basis of 35,000 acre project. The original Columbia Southern project consisted of 27,000 acres of Carey Act lands of which about 17,000 acres were sold. As set forth in Exhibit No. 1, the lands that were included under the old project are divided into four classes: A, those that have irrigated at least 15% of their contract holdings before November, 1909, and are entitled to a complete water right under the new constructed reservoir system by the payment of \$15.00 per acre additional to the old lien; B, those that had not irrigated 15% of their holdings prior to November, 1909, but who are willing to retain the lands embraced under their old contracts under the increased lien of \$50.00 per acre, receiving credit, however, on their new contracts, for all sums previously paid; C, those that had not irrigated at least 15% of their holdings prior to November, 1909, and who are now willing to surrender and cancel their contracts upon the issuance to them of preferred stock in the new reorganized company to the

amount that had been previously paid on their contracts; D, those lands under the original Columbia Southern project that remain unsold. The new lien established by the State on classes C and D is an average of \$66.00 per irrigable acre, which also applies to class E which is a new Carey Act segregation of 4,700 acres. For all non-irrigable lands embraced under the Carey Act an average lien of \$3.75 applies. For water-rights to private lands I believe a price of \$50.00 per acre to be very reasonable, and as there is a great deal more land available than water there should be no trouble to dispose of same for that price.

Under class "A" there will be about 3,000 acres of irrigable land, the owners of which will pay \$15.00 per acre in addition to the amounts due on their former contracts. The amount due under this class on the old lien is about \$15,000.00 making a total of \$60,000.00 returns from this class.

Under Class "B" there will be about 3,000 acres of irrigable land which will be sold for \$50.00 per acre. A credit of about \$30,000 will have to be made for amounts previously paid which would leave \$120,000 returns from this class.

Under Classes C. D. E. there is available about 18,000 acres of irrigable land which can be sold for an average price of \$66.00 per acre, bringing in returns of \$1,188,000. This land will be sold for prices ranging from \$50 to \$75 per acre. There will also be returns from about 6200 acres of non-irrigable land under these classes at an average price of \$3.75 per acre, or \$23,250. In order to sell the lands in Class C it will be necessary to make arrangements with the holders of contracts to cancel same. This has been done with the great majority, in that they have agreed to accept preferred stock in the new reorganized company in par value of the amount previously paid on their contracts. It is estimated that about \$85,000 worth of preferred stock will be necessary to cancel these contracts, as set forth in the summary of total cost on page 40.

For all lands under Classes C, D and E, or about 24,200 acres, a payment of \$1.00 per acre must be made to the State under the terms of the contract in Exhibit Number 1.

From the lands purchased in connection with the reservoir there will be available about 600 acres of private lands owned by the company, above the limits of the water surface of the reservoir. As these are choice lands already improved they could no doubt be sold for \$75.00 per acre including water rights, bringing in returns of \$45,000. This would leave water rights available for 10,400 acres of land in private ownership, that could be sold for \$50.00 per acre, or \$520,000.

A complete summary of the return for land sales would appear as follows:

3,000 acres of class "A" at \$15.00	\$ 45,000.00	
Amount due under old lien	15,000.00	
Total		\$ 60,000.00
3,000 acres of class "B" at \$50.00	150,000.00	
Credit for previous payments	30,000.00	
Total		120,000.00
18,000 acres of classes "C," "D," "E," at \$66.00	1,188,000.00	
6,200 acres non-irrigable land at \$3.75 per acre	23,250.00	
	\$1,211,250.00	
Credit to State, 24,200 acres at \$1.00	24,200.00	
Total		\$1,187,000.00
10,400 acres, private water rights, at \$50.00 per acre..	520,000.00	
600 acres, private land and water rights, at \$75.00 per acre	45,000.00	
Total		565,000.00
Total returns from the sales of land and water rights (35,000 acres at average \$55.20)		\$1,932,050.00

Arrangements for the sale of water-rights before the lands are reclaimed have been made as set forth in paragraph 10 of exhibit No. 1. The interest on deferred payments, however, will not commence until the water is available.

By using the Wimer Canal however about 2,000 acres of new land in addition to the 600 acres of private lands could be watered by the spring of 1913. If construction was commenced in the near future and carried forward with speed, I estimate that about 10,000 acres could be watered in 1913. The sale of lands and water-rights however could commence at once, and as soon as the water is available to the lands the interest on deferred payments could commence. With the splendid transportation facilities at hand, the lands should sell rapidly, but in case all the lands are not sold when the works are completed, the lien as established by the State will increase at the rate of 6 per cent per annum. All the works should and could be easily completed by the spring of 1914.

On certain assumptions as to probable sale of lands by certain dates, Exhibit No. 6 has been prepared, which shows a complete financial table, and also the basis on which it was prepared.

PLANS, SPECIFICATIONS AND PHOTOGRAPHS.

The above estimates have all been made in accordance with the plans and specifications covering the work of the whole project, which accompany this report and are made a part

hereof. Photographs showing portions of the unimproved lands, location of some of the important structures, and views of different crops under the project are also included herewith. The following classification may be referred to:

Exhibit No. 1—Preliminary contract between the Desert Land Board of the State of Oregon, and Mr. Alma D. Katz with a copy of the permanent contract attached.

Exhibit No. 2—Plans.

Exhibit No. 3—Specifications.

Exhibit No. 4—Photographs.

Exhibit No. 5—Soil Analysis.

Exhibit No. 6—Financial Sheet.

Exhibit No. 7—Copy of D. C. Henny's report.

CONCLUSIONS.

The water supply has been discussed at some length and I consider the amount available ample for at least 35,000 acres of irrigable land.

The duty of water as fixed in your contract with the State is ample for the crops suitable for the project. The soil, climate, location and condition in general are such as would make a very good dairying community. With the assurance of good crops of alfalfa, clover, timothy, vegetables of all kinds, and garden truck, the lands are valuable. I consider the unimproved lands with water-rights easily worth \$100 per acre, so they are good security for the liens as established for water-rights. Lands under the project partially improved have already been sold for as high as \$125 per acre.

If the project is constructed as planned, it will have a comparatively small portion that will have a heavy maintenance charge. About 6,000 feet of flume in the feed canal and the wooden structure of the distribution system will probably have to be replaced about once every 8 or 10 years. A sinking fund of 25 cents per acre annually will provide for this. In addition I estimate about \$1.00 per acre annually ought to cover the maintenance and repair work, water superintendent, ditch riders, clerical work, etc. I, therefore, recommend that the maintenance fee be fixed at \$1.25 per acre per year, as allowed by your contract with the State.

The total cost of the constructed project at \$817,829 and the net returns from the sale of lands and water-rights at \$1,932,050 shows a profit of 135% on the original investment. With the provisions in your contract that you can commence

the sale of lands and water-rights as soon as construction is commenced, funds and securities will be available as returns as soon as the project is completed and water available for the lands. I consider the project very feasible and attractive from every standpoint.

In regard to the amount and method of payment for the lands I should consult the purchaser and give him some choice provided he can pay at least one-fifth cash, and can pay at least one-tenth annually with interest on the deferred payments at 6%.

The engineering features of the entire project are all simple requiring no special consideration nor complications. The works planned are all standard type without any special feature of danger or risk, and can be constructed on a force account basis or can be let by contract. There is of course some risk attached to all reservoirs until they have been tested by being filled with water. The reservoir planned for this project has less objectional features than most of them, in fact all the conditions and investigations show that Tumalo reservoir should make an entirely satisfactory, safe, reservoir. The unit prices and other estimates are liberal and I believe that the works can actually be constructed with a saving over the estimates.

Very respectfully submitted,
(Signed) O. LAURGAARD,
Irrigation Engineer.

NOTE: The exhibits referred to in the above report are not reproduced here owing to the excessive length of some, and the difficulty of printing others without great expense for cuts. The report, with exhibits is on file in the office of the State Engineer, and members of the legislature, or others interested are invited to examine same.

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